CONVERSATIONS

ON THE

ANIMAL ECONOMY.

BY A PHYSICIAN.

IN TWO VOLUMES.

VOL. I.

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TO

THE AUTHOR

OF THE

CONVERSATIONS ON CHEMISTRY.

MY DEAR MADAM,

present little work aims at communing, on a plan similar to that which have so successfully adopted, some nation on the structure and functions Animal Body. I cannot flatter myself with having succeeded in removing all the difficulties which attach to a popular consideration of such a subject; much less with having imparted to it any portion of the attraction which you have given to Chemistry, Natural Philosophy, and Political Economy. I have endeavoured, however, to present a general and intelligible

view of some of the principal facts an. doctrines of Physiology; and hope it may be of use in giving correct ideas on this branch of Natural Science, in which the best educated, and most able part of society, are often but very little informed.

The admirable work of Archdeacon Paley, and the Lectures which have been delivered at the Royal, and other Institutions in this country, have produced, in the public, an interest relative to the A Economy, which I shall be happy if little volumes may at all tend to pro or to gratify.

I remain,

With gr eat regard,

My dear Madam,

Your faithful Friend, and

Respectful Servant,

THE AUTHOR

June 24. 1827.

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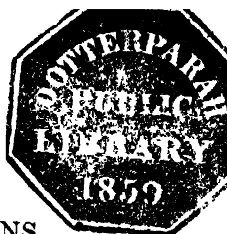
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CONVERSATIONS

ON

THE ANIMAL ECONOMY.

CONVERSATION I.

OF THE INTEGUMENTS.

DR. A.

I TOLD you, a little time since, that after you had made yourselves pretty well acquainted with the rudiments of CHEMISTRY, NATURAL PHILOSOPHY, and POLITICAL ECONOMY, by means of the pleasing little works which I put into your hands last year, I should have another subject in store for you, and I cannot do better than introduce it when your brother is with us.

HARRIET.

I recollect your observation, and look forward, with much pleasure, to the same agreeable mode

of receiving instruction, which you have before been kind enough to afford us. It is delightful to hear of a new set of Conversations. Pray what is the subject of them?

DR. A.

They are neither printed, nor sent to the press; and you will be surprised when I tell you, that in this new object of your attention, I purpose being your instructor myself. What think you of a little professional information?

HARRIET.

Why, papa, it is hardly possible that those who live in the house of a physician should not frequently hear medical subjects talked of; but is it really your intention to give us some instructions about the cure of diseases?

DR. A.

By no means. The cure of diseases is the province of the physician or the surgeon, just as it is that of the clergyman to preach sermons, and of the lawyer to bring actions and plead causes; but I need hardly say, that the studies of religion appertain to all, though the sacred duties of the pulpit and the altar belong to a certain set of men educated for the purpose of exercising them; and Charles will tell you, that though it requires a long series of laborious studies to fit a man for the practice of the law, yet there is much elegant and

useful information in its preliminary branches, and much that it is incumbent on every well-educated English gentleman to know. Just so it is in physic. A very useful share of knowledge may be obtained, as to the structure of the human frame, for example, without a person being led to dabble in the treatment of its diseases; and there is no subject which is better adapted than this, to excite wonder and admiration at the power, wisdom, and beneficence of the great Creator. This, in fact, is the subject which I mean to offer to your attention.

CHARLES.

I am very glad to find that you intend giving us a little information about the structure of the animal frame. I have often wished for it; and, indeed, have had serious intentions of attending a course of anatomy, that I may be better prepared to treat some of the cases which occasionally come under the consideration of the lawyer. But how will you, girls, be able to bear with anatomical descriptions, with accounts of bones, muscles, and joints?

DR. A.

Never fear; I shall not make the subject repulsive. It is only so in its associations; and I trust you will soon learn to contemplate the animal economy, as a centre of wonderful design, and admirable aptitude for the purposes of its creation.

SOPHIA.

Indeed, papa, considering how often physic and anatomy are talked of in public companies, it seems to be somewhat proper that people should know a little of the subject of their conversation, rather than descant on matters of which they are entirely ignorant.

DR. A.

I hope I shall soon be able to show you, that the acquisition of a very useful and agreeable quantity of knowledge, relative to the human frame, can be very readily and pleasantly obtained.

In commencing operations, I shall begin at the surface of the body, and first tell you a little about the external coverings, or INTEGUMENTS, as they are called.

SOPHIA.

What, are there more coverings than the skin? I thought that on breaking the skin you got at once to the flesh.

DR. A.

This is rather a hasty, but not an unusual conclusion; and I must anticipate so far my observations, as to tell you, that what you term flesh, is known by the name of muscle, and is that particular substance which is employed in moving the different parts of the body. It lies under the integuments, which are an outer covering and protection to this, and the various other parts below them.

SOPHIA.

Do you mean, then, that all the fleshy parts of animals are appropriated to moving some part or other of the body?

DR. A.

Certainly. There is no part without its use. All the variety of structure of which, as I shall explain to you, the body consists, is subservient to some important effect in the constitution of the animal; so that, if, like the members in Æsop, any one part were to set up a sort of independence of the rest, or to assume any kind of pre-eminence, it would soon discover the error of its reasoning. The integuments form that substance which covers every part of the surface of the body, which is movable over it in all directions, and can be readily taken hold of, and elevated in a mass, separable from the parts beneath. They constitute what is termed the hide in various animals, and consist of three parts; the *scarf-skin*, a *mucous net-work* below, and the *true skin*, which last forms the greatest part of this external covering.

HARRIET.

Then it appears that the common notion relative to the skin, of its being merely the smooth outer bark of the body, is erroneous.

DR. A.

Completely so; for what is usually known by the name of the skin, is nothing more than a thin, insensible pellicle, called the scarf-skin, or cuticle, which is intended to protect the parts beneath from injury, and to preserve their sensibility.

CHARLES.

In fact, it may be considered as bearing the same relation to the skin, which the rind of a tree does to the bark.

DR. A.

Very much so; and it is capable of being separated under various circumstances. A blister, for example, will, by throwing out a small quantity of fluid from the parts beneath, raise the scarf-skin, and make it apparent. Strong work will harden it, as in the hands of labouring people; and, after many severe complaints, the scarf-skin peels off, just as it does in some animals, as serpents, who cast their skin at certain periods: but in those cases, this does not happen till another scarf-skin is formed below, which serves to throw off the old one; so that the sensible skin is never left unprotected. In cases where scarf-skin has been lost, the parts below have a power of throwing out a material which hardens into this particular substance.

HARRIET.

But you spoke of the scarf-skin being insensible: I do not understand how this can be

the case, when we feel so acutely over all our frame.

DR. A.

We feel through the intervention of the scarf-skin, which is diffused over every part of the body in the closest manner, in order to protect the sensibility of the parts beneath; and even dips, to a certain extent, into the tubes which lead into various internal parts of the body. When it is very hard, or much thickened, the sensibility is diminished, or entirely taken away. If, however, impressions were made directly upon the parts below, the feeling would be too greatly excited, and would amount to pain; as may readily be known when any portion of cuticle happens accidentally to be removed.

CHARLES.

One continually hears of pores in the skin. Are these openings for the purpose of suffering any thing below from escaping?

DR. A.

The scarf-skin has in it numerous minute holes or pores, as they are termed in common language, by means of which certain important effects, as we shall afterwards see, are produced; and through some of which the hair issues.

Some anatomists are, however, disposed to deny the existence of any other openings than such as are destined for the passage of hairs. They con-

sider that the tenuity of texture, and bibulous, or absorbing nature of some parts of the scarf-skin, will allow of perspiration passing through it, and will also admit of its imbibing certain substances from without.

I would observe, however, of this opinion, though an ingenious one, and supported by a late able and excellent professor of the Royal College of Surgeons, that the difficulty of discerning minute holes or pores, is not a decisive argument against their existence, since we cannot discover the open mouths of minute vessels, though assured (as we shall afterwards find) that they possess such open mouths as one of their modes of termination. It may likewise be remarked, that the loss of power which attaches to the cuticle, of transmitting a fluid through it, when raised by a blister, is equally applicable to it in whatever way such transmission takes place; and that, on the hypothesis of bibulous transmission, an union to the parts beneath is equally necessary as in the case of minute pores or holes.

HARRIET.

The colour of the scarf-skin, I presume, varies according to differences in complexion and race?

DR. A.

Very little so; for even the scarf-skin of the negro is but very slightly darker than that of the

white. The seat of colour is, in fact, a very thin layer, not thicker than the cuticle, of a soft substance, which is interposed between the scarf-skin and the cutis, or true skin, and is termed the *rete mucosum*, or *mucous net-work*. In the negro, it is, as may be supposed, of a very dark colour; and the colouring matter is capable of being communicated to water, rendering it turbid, and subsiding in the form of a fine carbonaceous powder.

HARRIET.

Then I suppose the dark colour does not descend deeper?

DR. A.

Not at all: the true skin and the parts below are of the same colour, both in whites and blacks. Oxymuriatic acid will render the rete mucosum yellow in negroes, and immersion in water will take away much of the colour. But in the living body it is soon restored.

SOPHIA.

There must, I suppose, be a great number of different colours, or rather shades of colour, among mankind?

DR. A.

There are five principal varieties of colour in the human species, and all of them dependent on the different shades of this mucous coat:—the first is the EUROPEAN, or white; the second is the

MONGOLIAN, yellow, or olive; the third is the AMERICAN, red, or copper colour; the fourth is the ETHIOPIAN, or black; the fifth is the MALAY, brown, or tawny.

SOPHIA.

The European has certainly a great advantage over other colours of countenance, in the power of communicating expression. One can hardly conceive any change of appearance capable of being produced by emotions of mind in other varieties of complexion.

DR. A.

You are perfectly right; and hence it is said, in Spanish America, as an indication of the contempt which the Europeans bear to the natives, "How can those be trusted who know not how to blush?" In the Mongolian there is, however, when the skin is particularly fine, a slight approximation to change of colour, under powerful emotions of mind.

CHARLES.

Would a similar experiment to that which you mention, relative to the skin of the negro, show a deposit, after infusion in water, in the other darker varieties?

DR. A.

I do not know that the experiment has ever been tried; but, at any rate, the quantity of the colouring material would be much less. In very

fair European skins, it has even been by some considered, but without sufficient evidence, as altogether wanting; for though the colouring matter may vary, and in very white skins be altogether wanting, the organ on which it is deposited seems always to exist.

CHARLES.

The colour of the hair, I suppose, depends on the same cause as that of the skin?

DR. A.

To a certain extent; but the origin of the hair is deeper seated, though it takes a shade in passing through the mucous net-work. There seems, however, to be an actual difference in the colour of the rudiment of the hair, connected generally, but in a way not sufficiently known, with the peculiarities of the skin. Some have indeed imagined, that the colour of the skin is produced, or secreted, as we term it, from the bulbs of the hair, because it has been found, on its being removed by blisters, to re-appear at the pores or openings through which the hairs protrude; and also, because there is less colour on such parts as are without hair, as the soles of the feet, and the palms of the hands, than in other parts of the body where hair exists. There seems, however, to be every reason for imagining, that the secretion of this colouring matter is a property of the true skin

generally; for not only are there occasional anomalies in the colour of the hair, as compared with that of the skin, but the palms of the hands, and soles of the feet, are never without considerable colour; and some parts likewise, which are without hair, are occasionally black, as the inside of the lips.

CHARLES.

I recollect that President Jefferson, in his Notes on Virginia, mentions having seen white negroes: are they without the organ of colour, if one may employ such an expression, or does their peculiarity arise from any particular disease?

DR. A.

It is quite the result of natural conformation, and seems to arise, as you suppose, from a want of the power which produces colour in the body. It occurs among persons of all colours, and constitutes what is termed an albino. It exists, likewise, in some quadrupeds; and whenever it occurs, whether in them or the human species, the hair is exceedingly light coloured, soft, and silky; and there is generally a very remarkable peculiarity in the eye, which I shall more particularly explain to you when we come to that organ. Suffice it to say, that the pupil, instead of being black, is red, from the absence of that colouring matter in the body of the eye which exists in ordinary cir-

cumstances. The eye is preternaturally susceptible to light, is kept generally half shut, and is continually twinkling during the day, being better adapted to seeing in the shade, or in the dusk, than in broad daylight. A female was exhibited in London, some years since, in whom these peculiarities were very strikingly evinced.

HARRIET.

I should be curious, Charles, to know something about the white negroes of whom Mr. Jefferson speaks.

CHARLES.

He mentions seven instances of this peculiarity, of which six were in females, three of whom were sisters. They were all the offspring of negroes: one of these had an albino child, and three others had children which were black.

DR. A.

It sometimes happens that the colouring matter of the skin is wanting in particular places; and hence arises white patches of various dimensions, which, in the negro, make a very extraordinary appearance. There was a curious example of this peculiarity seen in a negro boy, in London, a good many years ago.

The true skin forms, as I have mentioned, the principal part of the integuments, and constitutes the organ of touch.

SOPHIA.

But touch is not equally perfect over the whole body. In order to feel, we employ the fingers; and hence, I suppose, they possess, in a greater degree than other parts, the feeling power.

DR. A.

The power of touch exists in the greatest degree, unquestionably, at the ends of the fingers, in slight elevations of the skin, called papillæ. The immediate organs of sensation are, however, small white threads, called nerves, which are more or less immediately derived from the brain, and these are diffused very plentifully over the ends of the fingers, and particularly the papillæ, which, by this means, are calculated to communicate minute impressions with great accuracy.

HARRIET.

I had no idea that there were actually such things as nerves. One hears of nervous people, weak nerves, and disorders of the nerves; but I always fancied that these were other names for fanciful or overcharged complaints.

DR. A.

And so they often are, in common language; but in speaking of nerves, in a more precise and correct manner, you must consider them as having as much a separate existence as bones or flesh.

Most animals have, independently of the general diffusion of sensibility over the surface, some particular part which possesses the sense of touch in a pre-eminent degree. The nose or snout is a very common organ for this purpose in many animals; and with the elephant, large and unwieldy as it is, the extremity of the trunk is provided with an organ, as small and delicate as the human finger, and capable of taking hold of very small objects, as needles or pins, with great facility.

SOPHIA.

I recollect perfectly a small projection at the end of the trunk of the elephant which we saw at Exeter 'Change, like the extremity of a finger, which seemed to be in continual motion, as if in search of something to take hold of.

DR. A.

This is what I mention; and it acts by doubling upon the nostril. When it has laid hold of any thing, it can at pleasure convey it into its mouth, by the curving of the trunk, which has an extraordinary facility of motion.

The skin is largely supplied with blood-vessels, which, it is sufficient to say at present, are very small hollow tubes, conveying blood for the nourishment of the different parts of the body. It has also other vessels passing through it, some of

which carry off what is intended to be thrown out, others which absorb what is designed to be taken in. It is of a dense, fibrous texture, very extensible, but not admitting, like the scarf-skin, of the supply of any part which may be lost.

HARRIET.

But do you mean to say, that if a portion of skin is cut out, or taken off, it is not again supplied?

DR. A.

The part will heal; and, if the skin is brought together very correctly, the cut portions will unite, so as that hardly any mark will remain: but the mark, scar, or eschar, as it is technically called, is a part without skin, and is therefore more liable to injury than before the accident, because less supported. The small-pox and cow-pox, in the marks which they leave behind them, afford an exemplification of the same thing. There is, in each of these diseases, a slight destruction of the skin, in the pustule or vesicle, which is not filled up or repaired, as you may see in the cow-pox mark in each of your arms.

The skin has a certain elasticity in young and middle life, but it does not contract with the muscles situated below it; and hence it forms various folds, which, in the countenance particularly, give a certain variety of expression. It is connected to the parts below by a sort of net-work,

called cellular membrane, and this being soft and extensible, admits of the easy motion of the skin over the parts below. It becomes more rigid as we advance in life; the adhesion is more firm; and hence the depressions are produced which form wrinkles, particularly in thin people.

CHARLES.

I recollect that in the Conversations on Chemistry there is a description of the mode of producing leather; and an interesting example is given of the process, in the mixture of an infusion of oak bark, which possesses in it the tanning principle, with gelatine or isinglass; the product being a firm yellow matter, insoluble in water. The skin of animals has in it, I presume, a large quantity of this particular substance, gelatine, which enables it to undergo that change.

DR. A.

You are quite right. The tanning principle of the oak bark unites with the jelly, through the whole substance of the skin or hide, and produces the change to which we owe so many important parts of our dress, as well as a great number of our most useful implements.

HARRIET.

Is leather thus formed simply by immersing a skin in a strong impregnation of oak bark?

DR. A.

This is the material part of the process; but then there are several accessory ones which I shall describe to you. In the first place, a hide is thrown for a day or two into water, to free it from any impurities which attach to it. It is then laid upon a half cylinder of stone, called a beam, where it is cleared of any adhering fat or flesh. Afterwards, it is thrown into a pit, containing a mixture of lime and water, where it is kept several days, in order to loosen the hair, which is scraped from it on the beam, by a blunt knife, having a handle at each end. It is then put into what is called the mastering pit, with some putrescent material, generally the dung of hens or pigeons, by means of which the hide becomes softened. After it has been again well scraped on the beam, it becomes fit for conversion into leather.

HARRIET.

What a very troublesome preparatory operation! But, as lime is a very corrosive material, I should have thought that the texture of the leather would be injured by its influence.

DR. A.

So it would, if care were not taken to separate it; but when the hides are very thick, and there would be danger of some of the lime being retained in the skin, which it would render so hard

as to be apt to crack, then the liming is omitted, and the separation of the hair is effected by heaping the skins together for a short time, in order to acquire a certain degree of putrescence. In this case, the final preparation for tanning is effected by immersing them in an acid solution, which seems to open the pores, and to fit the hide for the action of the tan.

HARRIET.

But is the tan able to pierce sufficiently the substance of a thick hide, by merely immersing the latter in a strong infusion of the former? One would imagine that the outside would become hard, before the interior could be sufficiently acted upon.

DR. A.

It certainly would; and therefore the skins are exposed, in the first instance, to very weak infusions of the bruised oak bark, which are gradually made stronger and stronger, to the utmost extent. The process is therefore very tedious; eighteen or twenty months being required for the manufacture of the thickest leather, and three or four months for common calf-skin. There is a considerable accession of weight in the formation of the leather, even after the drying is over. This last is effected by hanging the hide in a drying-house, exposed to a free circulation of air.

SOPHIA.

I suppose there is a general similarity in the skins of all animals, so as that they all admit of a conversion into leather by the proper means.

DR. A.

All of them; and even some of the finer membranes are capable of being converted into leather. Here is a specimen of leather made from a portion of the skin of a man who was executed for murder; and I have seen leather prepared from the most delicate skins of birds.

The process, however, which is employed in the fabrication of leather from thin skins, as those of sheep, lambs, goats, &c. requires more nicety, and is carried on as a distinct business. More previous care is necessary in the preparing them for the conversion into leather; and, instead of oak bark, sumach is often employed for the purpose, which is a gum containing a great deal of the tanning principle. In the white skins, however, *tawing* instead of *tanning* is employed; and this consists in an exposure to a solution of alum and salt in warm water, by which a conversion into leather is effected.

SOPHIA.

Are the different varieties of leather, such as Morocco and Russia, dependent on the nature of the skin, or the process employed in the fabrication?

DR. A.

A little on both, but principally on the latter. The real Morocco is made at Fez and Tetuan, from goat-skins, and is prepared by sal gem, or rock salt alone, and not by salt and alum. It is, of course, coloured subsequently, as is the Morocco of this country, which is made of goat-skin, and tanned by sumach. The Russia leather is generally tanned by the bark of the black willow or the birch; and after being coloured is smeared over with birch tar, which gives it its peculiar and characteristic smell.

In the preparing of leather for the purposes for which it is intended, there are various other processes necessary, of which a very important one, for such leather as is to resist wet, is currying, which consists principally in impregnating the leather, with curriers' (generally fish) oil, which penetrates deeply into its pores. Graining is made by friction with box-wood balls, having parallel grooves on them; and the barred surface of Russia leather, by the pressure of a very heavy steel cylinder wound round with wires.

CHARLES.

Glue, I think, is a species of jelly. Is this procured from the skins of animals?

DR. A.

The skins of animals will furnish it; but so will every other substance (of which there are many)

which contains jelly. It is generally procured by boiling the parings of hides and horns of any kind, the pelts from furriers, the hoofs and ears of horses, oxen, calves, sheep, &c.; and after the jelly obtained by such boiling is purified, it is boiled down, put into frames cut into proper sizes, and hardened by exposure to the air. Isinglass is a finer kind of glue, or a very pure jelly, which is prepared, principally in Russia, from the air-bladder and different parts of the entrails of various fish, particularly the sturgeon, by little more than cleansing, cutting out, and drying.

SOPHIA.

Is hardness of the cuticle, when it occurs in working people or others, owing in any way to a sort of natural tanning which it undergoes after its production?

DR. A.

This is an ingenious hypothesis; but, unfortunately for it, the nature of the skin and cuticle are very dissimilar; the skin principally consisting of gelatine or jelly, the cuticle of albumen, or that particular substance which forms the white of an egg. Now an important distinction of jelly is its great solubility in water, and its forming an insoluble precipitate with infusion of oak bark; while the great characteristic of albumen is its coagulating by heat. The analogy which exists between the nature of scarf-skin and albumen,

and the circumstances which show that the former is a modification of the latter, are evinced by both of them becoming yellow by the action of nitric acid, and having the yellow tinge changed to a purple, by means of ammonia.

The hardness which you speak of is capable of being produced by mere pressure, of which the soles of the feet and palms of the hands afford remarkable examples: for though the scarf-skin is naturally thicker in these than in other parts of the body, yet in neither the feet nor the hands could it sufficiently protect the parts beneath from the effects of great exercise, either in walking or labour, unless for the wise provision of having its thickness, and consequently its power of resisting injuries, increased by use. The immediate cause of this augmentation seems to be a curious power, possessed by the skin itself, of furnishing additional materials for the fabrication of scarf-skin, whenever increased pressure seems to indicate a necessity for such augmentation in the protection required.

HARRIET.

Do the skins of other animals admit the same division as that of man, into epidermis, mucous net-work, and true skin?

DR. A.

Pretty nearly so, but with some modifications, depending on the particular nature of the animal.

Some animals, for example, have an exceedingly thick epidermis or scarf-skin, as the elephant and hippopotamus; and even in the human race, the scarf-skin, in some few cases of disease, assumes a hard, irregular, dark-coloured and scaly character, known by the name of ichthyosis, or fish-skin. Instances have been known of a change of cuticle into a brown, thick, hard, and insensible substance, with projections like porcupine's quills; and this totally independent of disease, in the individual having so singular a peculiarity.

HARRIET.

We must, I think, view the cuticle as an important defence to the skin in all animals.

DR. A.

Certainly; and its nature varies according to the medium which they occupy. Those which live in air have their cuticle dry and horny; fish, on the other hand, have it mucous, viscous, or oily, so as to prevent injury by the action of the water upon it. Some animals, I have already observed, as serpents, cast the cuticle once a year, and this in so perfect a way, as that there is even the rotundity of the eye itself discoverable in the exuviæ.

CHARLES.

The scales of the serpent and fish are, I conclude, composed of thickened cuticle.

DR. A.

They have their origin in the skin, and are covered by a thin cuticle or epidermis; but they are not a part, or modification of cuticle, being of a much firmer and harder material. Insects, whether in the larva state, or in that of the pupa, or of the perfect animal, have a true cuticle; but as this, when once dry and hardened, no longer admits of being stretched, so as to accommodate itself to increase of growth, it is thrown off by the larva, as a sort of sheath or case, as soon as the animal has acquired a certain size. This operation, however, takes place at a defined period for every species; and depends, to a certain degree, on atmospheric temperature. Insects are said to be moulting at this crisis, and they are often many days in preparing themselves for it. It sometimes proves mortal to them. The greater part of silkworms, and of the caterpillars of butterflies, cast off their cuticles seven times; and some insects even ten times before they pass into the state of chrysalis.

SOPHIA.

I am ashamed to be under the necessity of requesting you to give us the meaning of those terms, the precise signification of which is not quite in my recollection.

DR. A.

The perfect insect lays its eggs, which form the

first state of the animal. These produce the worm, grub, caterpillar, or larva; which last term is given, because the animal is supposed, in this state, to be under a sort of larva or mask.

The third state is that of the pupa, which is so called from the resemblance to a swaddled child. Synonymous with this are the terms, nymph, aurelia, and chrysalis.

The fourth and last state is that of the perfect insect, imago, or complete image of its species.

CHARLES.

The skin itself, I suppose, as well as the cuticle, varies in thickness in different animals?

DR. A.

Very much so; and in different parts of the same animal, as the back, where the skin is much thicker than elsewhere. There is a peculiarity in the attachment of the skin of the frog and toad to the body, which does not apply to other animals. It is only adherent at a few points; being in other respects a loose bag, inclosing the body; whereas, in most animals, it is closely adherent to the muscular surface beneath, by means of cellular membrane, as I have already mentioned.

CHARLES.

You stated that the origin of the hair is deeper seated than the mucous network. It must arise, I suppose, from the skin itself; and, indeed, the slight

pain which is produced in drawing a hair out by the roots, evinces its origin to be in a sensible part.

DR. A.

Certainly. The hairs are more or less deeply seated, according to their magnitude; some arising nearly at the surface of the skin; others deep in its substance; while others of a larger size extend even below the skin. Each separate hair has a distinct origin in vascular pulp, which is contained in a capsule or covering, lodged either wholly in the body of the skin, or in part beneath it; and having a horny and insensible stem proceeding from it, which pierces through the outer part of the skin, the mucous network, and the scarf skin. The vascular pulp provides for the continued growth of the hair, which is hollow, and contains a small quantity of this pulp, to which it owes its nourishment, in a sort of cellular structure within it.

SOPHIA.

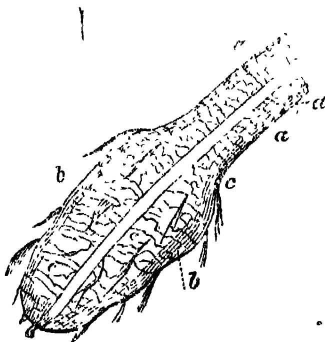
Is every hair then really a tube?

DR. A.

It is so; and a lens of moderate power will discover the tubular formation in large hairs, such as the whiskers of the cat, hare, or seal. These particular hairs, by the way, have, at their origin, a plentiful supply of nerves, which makes them useful as feelers, or organs of touch. The pulpy

matter extends only to that part of the hair which is in a state of growth; and when the hair is about to be shed, the pulp retires, and leaves the lower part of the stem of the hair, in some animals, converted into a solid pointed mass, easily separable from the part below, and in time pushed up from it. The hog's bristle is an example of this, which is thrown off and supplied by others in succession: but there is this peculiarity in the bristle, that it has two canals in its substance, and is composed of a considerable number of small filaments united together, as may be readily observed in a common brush.

I show you here, from a German work, the sketch of a hair from the eyebrows, magnified to a great extent by the solar microscope; (*a a*) being the body of the hair; (*b b*) the bulb; (*c c c*) little roots, which are attached to the bulb; (*d*) the tube or canal.



SOPHIA.

I always supposed, that when a hair was pulled out, its root was taken away, and it would not grow again; but, it would appear, that in such a case, there is only a separation of the upper part of it?

DR. A.

Certainly. The bulb, or material which forms the hair, is left; and hence, when the hair falls off, under circumstances of particular complaints, it is not irretrievably lost, but grows again as the person recovers strength. Most animals lose their coats at particular seasons, which they do by new hairs springing up, and displacing the old ones. In many nations it is customary to pull out the hair of the beard, particularly, by means of pincers; but this operation requires repetition at certain intervals, as you may now readily infer.

CHARLES.

You mentioned that the colour of the hair was not altogether dependent on the nature of the mucous network, inasmuch as its origin is deeper seated. This seems to be confirmed by the circumstance to which you have alluded, that fair people sometimes have dark hair.

DR. A.

This is certainly the case; and skins of the same shade will often have hair of very different colours and descriptions. In general, however, there is,

notwithstanding some occasional anomalies, a certain connection or relation between the colour of the skin and that of the hair and eyes; and with the varieties of colour by which different nations are distinguished, there are certain peculiarities, not only in the colour of the hair, but in its texture and disposition to curl.

SOPHIA.

How is the change of the colour of hair to grey accounted for?

DR. A.

This seems to depend, not only on the absorption, or removal of colour from the hair itself, but on the cessation of that influence on the body of the hair, by means of which its colour is maintained. It does not, however, appear to be necessarily connected with any diminution of power in the hair itself; for many persons have grey hairs, long before age gives them any claim to that distinction: and such people have generally rather less than more the usual tendency to baldness. The change of hair to grey is an effect which sometimes occurs very speedily. Passions of the mind have an extraordinary influence in producing this change, of which the French revolution is said to have furnished many examples. BICHAT, a distinguished French anatomist, relates that he has known five or six cases, in which the hair lost its colour in less than a week; and states, that he was ac-

quainted with one person, in whom the hair became grey in even a single night, in consequence of his hearing some distressing news. Some have imagined, that the speedy removal of the colour of the hair, in such case, is owing to the production of an acid; but this opinion, though supported by the authority of Vauquelin, a very eminent French chemist, does not seem to rest on sufficient grounds. There is, indeed, much obscurity in the subject.

The power on which colour depends is sometimes connected with temperature; for many animals of the Polar regions become white in winter, and recover their proper colour in summer. In this case, however, there is a new crop of hair produced for the winter, which is not only light coloured, but much more close and downy than the summer coat; and connected with the production of the warmer covering, is the singular suspension of the power on which the communication of colour depends.

An injury to a part will sometimes affect the production of the colouring material: as in horses, where the new hair is always grey.

CHARLES.

Do the singular productions of skin, which are possessed by the porcupine and hedgehog, bear an analogy to the hair of other animals?

DR. A.

A considerable one, both in nature and mode of formation.

HARRIET.

The clothing which hair is intended to give to quadrupeds is, I conclude, given by feathers to birds; but is there much similarity in structure and nature between feathers and hairs?

DR. A.

In nature they are very much alike, and there is likewise great similarity in structure. The body of a bird, which has just quitted the egg, is covered with a downy hair, instead of feathers. These hairs arise from one common bulb, which is the rudiment of the future feather. In a few days, a black cylinder appears, which opens at its extremity, and gives passage to the feather, while the hairs gradually separate. The growth of the feather is supplied by a pulp in its barrel, which is furnished by blood-vessels entering from below; and when the growth is completed, this pulp dries up, and exhibits the well-known shrivelled substance which is found in the barrels of quills. The immediate interruption which takes place to the growth of feathers, seems to be owing to the formation of new ones, which shoot up, and obstruct the supply of blood to those which have come to maturity, and which are therefore, in the course of time, thrown off. This process is called

moulting; but in order to lose nothing by the spontaneous separation of the feathers, the period is generally anticipated, in those birds whose feathers are in demand, by plucking them before the time that they would actually drop off.

HARRIET.

There must, I suppose, be a good deal of difference in the nature of the feathers of land and water birds.

DR. A.

There seems to be a sort of oily secretion furnished to those of the latter, which prevents them being soaked by wet, in the way that the former would be. This property, I have no doubt, gives them likewise a certain buoyancy, which is useful to them in swimming.

The coverings with which nature has furnished animals are, therefore, in every way accommodated to their particular habits or necessities. But their utility does not terminate with the animal for whose service they are immediately intended. They are of daily importance to man in various ways. We owe to them many of our most valuable articles of clothing; the softness and warmth of our beds and couches; and the materials of numerous indispensable domestic implements; while the plumes of the ostrich, and the skin of the ermine, furnish the most splendid decorations to

royalty itself. Last, but not least, in the scale of usefulness, is the quill.

CHARLES.

We cannot indeed be too grateful to the feathered tribe for this little instrument, through whose medium we have obtained the stores of knowledge which we possess; and to which we are indebted for the means of communicating with distant friends, and of giving permanence to evanescent thoughts.

DR. A.

A very handsome compliment to the poultry-yard, Mr. Charles, and one which it well merits, notwithstanding the occasional use of metallic pens.

The nails are another part of the integuments, and are insensible substances, of a nature similar to scarf skin, and firmly fixed to it, so as to separate with it after long maceration. They are formed from the skin, and are lodged in a doubling of it. They consist of thin transparent plates, and are intended as a defence to the organs of touch.

SOPHIA.

Would the nails, if left to themselves, grow, like the hoofs of animals, to a great extent?

DR. A.

They would curve over the ends of the fingers, and grow till they assumed a pointed form.—Claws and hoofs are given to various quadrupeds and birds; and

where the former are required to be kept very sharp, as in animals of the cat kind, there is a little apparatus provided, by means of which they are drawn into a kind of sheath, and thus preserved from injury. In general, however, the hoofs and claws are intended to preserve the feet of animals from being hurt by walking; or to give the necessary support to the toes, in the various operations which they are intended to perform. Where the hardness of roads would wear away the hoofs, as in horses, mules, and asses, an artificial defence, in the way of iron shoes, is given, which it does not appear that the ancients found necessary, and which are, with us, sometimes taken off when animals are at grass. The ordinary use to which hoofs and claws are applied, keeps them of a proper size, and prevents any undue growth; and we may see that the claws of birds, which are intended to assist them in grasping boughs with their feet, are obliged occasionally to be cut, where confinement prevents the exercise which is necessary to wear them down.

SOPHIA.

I perfectly recollect this being the case with a favourite Canary bird, which nurse had many years since: the poor thing was often quite a cripple till its claws were cut.

DR. A.

The Romans were very particular in their at-

tention to this part of the body; and during the period of their highest luxury, their barbers had the nails particularly under their care, trimming and cutting them according to prevailing fashion. It has been said by Le Compte, that among the Chinese, in his time, the doctors and other learned men suffered their nails to grow to an excessive length, not only as an ornament, but a distinction, to show that these personages were separated from mechanical arts, and were wholly addicted to science.

HARRIET.

This was as good an ensign as the gold-headed cane and the bag wig, which physicians, in this country, had of old; though it might interfere a little, it must be owned, with the feeling of the pulse.

DR. A.

Mankind always like to have the trouble saved them of examination into professional merits; and the cane, wig, or demure looks of the European doctors, and the long nails of the Chinese, were equally a sort of sign-post of their qualifications or pretensions.

SOPHIA.

I am very glad that the fashion has altered before our time; for it would be odious to see you with those decorations, and particularly with the sombre looks which it was once thought necessary for

physicians continually to wear, and which would totally freeze and repel all approaches to that freedom of intercourse which you kindly allow us.

DR. A.

Viewing physicians as friends, or men of science, the change has been favourable; but it is perhaps questionable, how far the profession, as one of which money is to be made, has gained by the removal of those external signs of dignity and sapience, to which the public are still apt to affix the possession of superior knowledge or attainments. Besides, it is to be recollected, that the legislature, in one of its earliest laws relative to the medical profession (and which by the by is still in force), enacted, that none should be allowed to practice physic but such as were 'profound, sad, and discreet;' which shows how much the exterior of a doctor was attended to in the time of Henry the Eighth. But this opinion was of still more ancient date; for Hippocrates, whom we deservedly call the father of physic, and who lived more than two thousand years ago, in his instructions to physicians, recommends them to have a meditative and pensive cast of countenance; without, however, appearing harsh or haughty; and by no means to indulge in laughter, or to be of too cheerful a turn of mind.

SOPHIA.

But whatever the ancients may have thought on the subject, or even our forefathers in more modern times, is it possible that the public can be so ignorant, now-a-days, as to be misled by mere exterior, instead of looking to real and substantial qualifications?

DR. A.

When a person is well known, he may be properly appreciated; but it is astonishing how little will bias the opinion of patients, or their friends, in the choice of a physician, or in the estimate which they may form of him. You must not forget, too, how much the respect for judges and counsellors is increased, by the formidable magnitude of their wigs, and the graceful flowing of their robes; and there is little doubt, that a portion of their dignity and consequence would be lost, if they were to exercise their respective functions without their appropriate costume.

But the long nails of the human race, however they may have been valued as embellishments, never could be put in competition, for active service, with the claws of various animals, which are intended to assist them in securing or tearing their food, in burrowing into the earth, in climbing trees, or in fixing themselves to boughs during their sleep.

CHARLES.

I suppose the horns of animals bear a considerable similarity in their nature to nails and hairs?

DR. A.

The chemical results are the same; all of them principally consisting, as does likewise the scarf-skin, of condensed or hardened albumen; a substance which I have already mentioned to you; but horns vary very much in their mode of growth. Some, as in oxen and sheep, grow from the bones of the head, and increase in length by additions at their roots; others, as the snout of the rhinoceros, is composed of a congeries of hair, glued together, and united firmly at bottom, but attached only to the skin, and hence allowing the snout to be slightly moveable; while others, as the antlers of the stag, are deciduous, being thrown off, and supplied, every year.

HARRIET.

I recollect seeing, I think at Dr. Harwood's lectures, a section of the horn of the rhinoceros, in which the hairs were exceedingly apparent; but what an immense growth the antlers of the stag must have, to be formed in the course of a single year!

DR. A.

In point of fact, these antlers, though they sometimes weigh a quarter of a hundred weight, are

completely formed in ten weeks: they drop off in the latter part of the year, and the part from which they originate soon becomes covered with skin. At the proper season, tubercles arise at the place from which the new antlers sprout; and they, in their turn, drop off to spring anew, but always more considerable in size. It must be observed, however, that the antlers of the deer tribe are very different from common horns. But I shall have occasion to advert to this subject again, when I explain to you the nature of bone.

CONVERSATION II.

DIVISION OF ANIMALS, AND VARIETIES OF MANKIND.

DR. A.

I MENTIONED to you, at our last meeting, the five different varieties into which the human race may be divided; and it is now my intention to point out to you some of the principal peculiarities which appertain to each. Before I enter upon this subject, however, it may be useful to make you acquainted with the division, or classification of the animal kingdom, which is adopted by naturalists of the present day, because I shall frequently have occasion to refer to various parts of it, in executing the plan which I propose for you.

LINNÆUS divided the animal kingdom into six classes; viz.

I. MAMMALIA, or the animals which suckle their young; which comprehend the human race, quadrupeds of all kinds, bats, seals, and whales.

II. BIRDS.

III. AMPHIBIOUS ANIMALS.

IV. Fishes.
V. Insects; and
VI. Worms.

These classes he divided into various orders, genera, and species; and when I tell you that his six classes consist of 33 orders, 449 genera, and 19,430 species, you may well imagine, how much natural history requires the aid of method, for its successful cultivation.

HARRIET.

I am surprised to hear you comprise bats and whales in the same class with man and quadrupeds. I should have thought that bats were birds, and whales, fish.

DR. A.

Bats have no other claim to being considered as birds, than that of their being able to suspend and move themselves in the air, just as some species of fish have likewise the power of doing to a certain degree. They have membranous arms instead of wings; are covered with hair; suckle their young; and have all the other analogies of the mammalia class. Whales, likewise, differ from fish, and agree with the mammalia in the important particulars of giving suck, and in the mode in which the blood circulates, and the respiration is carried on.

The division of the animal kingdom which is,

however, principally followed at present, is that of CUVIER, the French philosopher, who has so much distinguished himself, by his successful prosecution of every branch of anatomical and physiological knowledge: and as it is important to be well acquainted with the classification adopted by him, I shall give you a general account of it, with a more particular one of his first principal division.

Classification is, however, a thing which requires a good deal of minute attention, and I shall therefore draw out, for your use, in a tabular form, and give you, before our next meeting, the more material parts of the arrangement of both Linnæus and Cuvier, which you may look over at your leisure.

Cuvier first distributes the animal kingdom into four grand divisions, consisting of

I. VERTEBRATED ANIMALS, or those which have a vertebral column or back bone.

II. MOLLUSCA, or animals of a soft texture, having shells occasionally in some parts of their bodies, but not bones.

III. ARTICULATED, OR JOINTED ANIMALS, from the peculiar mode in which the different parts of their bodies are united together; and

IV. ZOOPHYTES, OR RADIATED ANIMALS, from the organs which they possess being placed round a centre.

The VERTEBRATED Animals Cuvier subdivides

into four classes; namely, the MAMMALIA, BIRDS, REPTILES, and FISHES.

The 1st class, the MAMMALIA, he divides into eight orders, of which he calls the

1st. *Bimana*, or the two-handed, which comprehends the human race alone: the

2d. *Quadrumana*, or the four-handed, which comprises monkeys of all kinds.

SOPHIA.

I am very glad that man has a place by himself; but I cannot understand why any animals should be termed four-handed. Are the feet of monkeys to be regarded as additional hands?

DR. A.

They are endowed with a power of grasping with the feet, as well as with the hands, by which means they possess the faculty of ascending trees with great facility. You may form a good idea of the difference between the shape of their feet, and ours, from the sketches which I now shew you; in which the first indicates the human leg and foot; the second those of the monkey, with its long and flexible toes, so well adapted for doubling upon, and grasping the boughs of trees.



The 3d order is the *Carnassier*, or Flesh-eating, which Cuvier divides into,

1. The *Cheiroptera*, or those having winged hands, of which the bat is an example.

2. The *Insectivora*, or those which live upon insects, as the hedgehog, shrew-mouse, and mole.

3. The *Carnivora*, or Carnivorous, which, again, he divides into four families; namely,

1. The *Plantigrade*, or those which walk on the soles of the feet, which, from being large, admit a great facility of standing on their hinder extremities. The bear, racoon, badger, and glutton belong to this family.

2. The *Digitigrade*, or such as walk principally on their toes, which include weasels, and animals of the dog and cat kind; as the dog, wolf, and fox; and the cat, lion, tiger, and leopard.

3. Some of the *Amphibious* animals, as seals and walruses; and,

4. The *Marsupial*, or *Pouched* animals, as the kangaroos, and opossums, which are remarkable for possessing a curious pouch, into which their young can creep for protection.

HARRIET.

I do not quite understand why Cuvier should adopt, as one of his divisions, the carnassiers or flesh-eating, and employ, as a subdivision, the carnivorous, a designation which seems to mean the same thing.

DR. A.

In using the general term carnassier, he would imply the simple fact of living on animal food; though this may consist principally of insects; but by carnivorous, he wishes to denote, not only the inclination to live on flesh, but the disposition and power necessary for obtaining such kind of food. The objection which you mention has certainly, however, much force in it.

Cuvier's 4th order is the *Rongeurs*, *Rodentia*, or *gnawers*, of which castors, beavers, rats, mice, hares, rabbits, and squirrels, are examples. They are so called, from having a remarkable power in their front teeth, of gnawing wood.

The 5th order is the *Edentés*, *Edentata*, or *toothless*, from the animals of this order being deficient in some or all the teeth. Sloths, armadillos, pango-

lins, and the curious and anomalous animal from New South Wales, called the ornithorinchus, belong to this division.

The 6th order is the *Pachydermes, Pachydermata,* or *thick-skinned,* and comprises the elephant, hippopotamus, hog, rhinoceros, horse, and ass.

The 7th order is that of the *Ruminant Animals,* or those which chew the cud; and it comprehends the camel, the deer, the antelope, the goat, the sheep, the cow, and the buffalo.

The 8th and last order of the Mammalia, is the *Cetacea,* or *Whale* tribe, and comprehends whales and dolphins.

Having thus, therefore, given you a general account of Cuvier's first division of the vertebrated animals, I must refer you to the table which I have promised you *, for any further particulars as to classification, and shall now direct your attention to a consideration of the varieties of the human race.

These varieties are, as I have already mentioned to you, five in number.

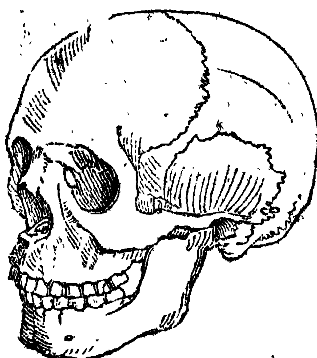
The first is the EUROPEAN, or rather the CAUCASIAN variety; for Blumenbach, a very distinguished philosopher of Gottingen, who adopts the division mentioned by me, employs the Caucasian as the general designation; first, because the

* See Table at the end of the Second Volume.

finest specimens of mankind are found among the Georgians and Circassians, who live near Mount Caucasus; and, second, because this is not far from the region where the earth first began to be peopled.

The Caucasian variety is distinguished by all the shades which characterise the white; and by copious hair, sometimes black, and frequently of various light colours. The head is large; the upper and fore part of it particularly developed, and the forehead expanded. The face is oval and straight, the features distinct, and falling perpendicularly below the forehead. These are the general characters which attach to all the Europeans, except the Laplanders; to the inhabitants of Western Asia, as far as the river Ob, the Caspian Sea, and the Ganges, and including therefore the Turks, the Georgians, Circassians, Arabs, Persians, and Hindoos of high cast; to the Northern Africans, and some Southern tribes; to the Egyptians, and Abyssinians; and to the Guanches, or the inhabitants of the Canary Islands.

The sketch which I now show you, is that of a Georgian's head, from Blumenbach's valuable work on the varieties of the human race.



CHARLES.

This division then, seems to comprehend every nation which has been in any way distinguished for civilisation, in either ancient or modern times.

DR. A.

It does so; and we may add to them, the various ramifications into which the enterprise of European colonisation has carried their respective races, in North and South America, in the West Indies, in Southern Africa, and in various parts of the eastern world.

CHARLES.

But in the various nations which you have named as belonging to the Caucasian division, there must be many varieties in the respective characters of face.

DR. A.

Certainly; but still they are referable, in a

greater or less degree, to the general description which I have given. The high cheek-bones of some nations, the aquiline noses of others, and all the minuter circumstances of colour of skin and eyes, are merely varieties of the same general character.

The second division is the MONGOLIAN, or yellow, which has a middle tint between that of ripe wheat, and boiled quince, or dried lemon-peel. This variety is characterised by black eyes, black, straight, strong, and thin hair; little beard; head of a square form, with small and low forehead; broad and flattened face, with the features running together; nose small and flat; rounded and projecting cheeks; eyes placed obliquely; narrow and linear aperture of the eyelids; slight projection of the chin; large ears; thick lips.

SOPHIA.

What a frightful assemblage of features! But why is this variety called Mongolian?

DR. A.

Because it is a distinction of the Mongols, Monguls, or Moguls, who are a very numerous tribe inhabiting Central and Northern Asia. The nations comprehended under this variety are very extensively diffused: they comprise, among many other smaller divisions, the Calmucks; the Chinese, and Japanese; the inhabitants of Thibet, Cochin China, Ava, and Siam; the Laplanders, and the Esquimaux.

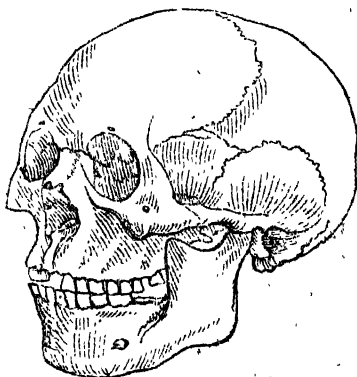
CHARLES.

It seems to be exceedingly curious, that the Laplanders should form an exception to the general character of the Europeans; and that these, and the Esquimaux, should have any thing in common with nations so far distant, and occupying regions of such very different temperature.

DR. A.

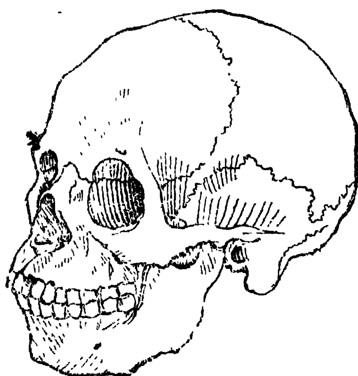
This is a very remarkable circumstance in the history of mankind; and it shews how pertinaciously distinctions are kept up, when nations remain unmixed.

You will observe a considerable difference between this sketch of a Calmuck's head, and that of the Georgian which I have just shown you.



The next division, the third, is the ETHIOPIAN variety. In this the skin and eyes are black; the

hair black and woolly; the skull compressed laterally, and elongated towards the front; the forehead low, narrow, and slanting; the cheek-bones prominent; the jaws narrow and projecting; the upper front-teeth oblique; the chin receding; the eyes prominent; the nose broad, thick, flat, and confused with the extended jaw; the lips, and particularly the upper one, thick. The projecting jaw, and retiring forehead of the Negro's skull, makes a great difference between this, and either of the two former sketches.



All the inhabitants of Africa, which are not comprehended in the Caucasian variety, are comprised in this.

CHARLES.

There must then, I suppose, be many varieties in this division.

DR. A.

A great number; and even some of them have, with the exception of colour, a considerable claim to personal beauty, though we should be hardly likely to expect this among the Caffres, or Negroes.

The fourth division, the AMERICAN variety, is characterised by a dark skin, of a more or less red tint; black, straight, and long hair; small beard; countenance and skull very similar to that of the Mongolian tribes; forehead low; eyes deep; face broad, particularly across the cheeks, which are prominent and rounded; mouth large, and lips rather thick. All the native tribes of America, except the Esquimaux, are comprehended in this variety; but the skin in many of them, particularly those of equinoctial America, and even of the Northern, is much more of a brown, than a copper colour.

The fifth division is the MALAY variety, and it has in it, less of a peculiar character than any of the other divisions. The colour is brown, from a light tawny, to nearly a black. The hair is black, abundant, and more or less curled; the head rather narrow; bones of the face large and prominent; nose full and broad towards the apex; the mouth large.

The inhabitants of Malacca, Sumatra, Java, and of most of the adjacent Asiatic islands; of the Molucca, Philippine, and neighbouring groupes; of

New Holland, New Guinea, New Zealand, and the numberless South Sea islands, are all of this variety; and it may be remarked, that among the East India islands, there is a division resembling the Negro in the character of the hair, in colour, and in the general form of the skull and features. Persons belonging to this division are called Negroes, or Moors, and are regarded as the aboriginals, whose ancestors were driven up to the mountainous districts, by the encroachments of new settlers.

CHARLES.

It can hardly be imagined, that the varieties of mankind which you have mentioned, should not have been very much blended together, in many places, by mixture of races.

DR. A.

This has certainly been the case to a considerable extent; but the Caucasian has been less affected in this way; on account, perhaps, in some degree, of the higher estimate in which the persons belonging to this class hold themselves, and the smaller number of the other divisions who settle among them. We find, however, that when colonisation has taken place, which it has done to a great extent from all the nations of Europe, to various parts of the world, and particularly to America, the blending of races has produced many changes of appearance.

CHARLES.

This must more remarkably be the case when different varieties live in contiguous districts, as in Africa; and I recollect that Mungo Park describes the Foulahs as being a link between the Moors and Negroes, as being of a less glossy black, having soft and silky hair, and as not having the flat noses and thick lips which characterise the Negro.

DR. A.

The Arabian and Saracen conquerors; the Phœnician, Greek, Roman, and Turkish colonists in the North of Africa; the Abyssinians on the East, and the Portuguese on the Western coast, would all likewise tend to produce differences, of a considerable extent, in the people among whom they settled.

SOPHIA.

And yet it is extraordinary how much the characters of invaders have been lost by residence in a conquered country. It appears as if a complete assimilation, in time, took place between them and the vanquished.

DR. A.

This will, of course, happen when the number is small; but in colonisation the case is different: the new comers keep a good deal to themselves, and enlarge their circles as their numbers increase; hence they often introduce a new language, and a

new race. Whereas if they went into the middle of a peopled country, as conquerors do, all traces of them would soon be lost. Blumenbach, who adopts, as I have already mentioned, the division of mankind into five varieties, considers the Mongolian and the Ethiopian as differing most from the Caucasian, and the American as coming in between the Caucasian and the Mongolian; while the Malay comes in between the Caucasian and the Ethiopian.

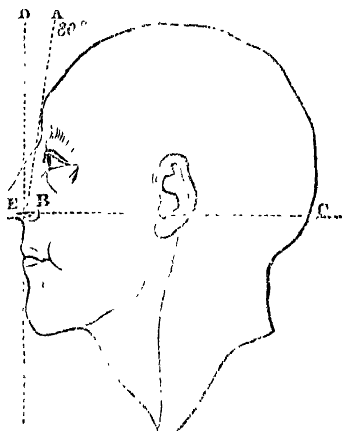
HARRIET.

I have heard of some philosopher who attempted to measure the comparative faculties of man and animals by a facial line and angle: what is meant by these?

DR. A.

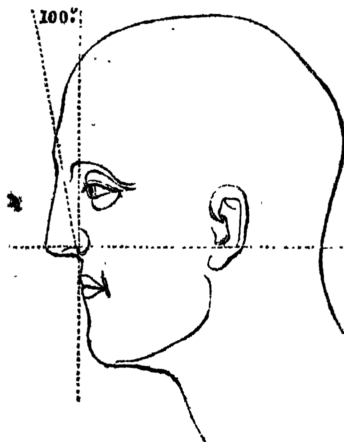
It was Camper; and his facial line is one drawn from the most projecting part of the forehead, to the most projecting part of the upper jaw. Now if you suppose a horizontal line to be carried backwards, from the base of the nose, to the opening of the ear, it is clear that the two lines, at their junction, will form an angle, which will be greater, according as the projection of the forehead, and the retirement of the upper jaw, allow the facial, to approach to a perpendicular line or not. You will easily understand this by a little sketch of a face in profile, in which I shall make AB the facial line, BC the horizontal line, and ABC the angle

formed by their intersection, or the facial angle. In this case, the perpendicular being DE, and the angle DEC being therefore a right angle, or angle of 90°, it is clear that the angle ABC is a little less; it is 80°.



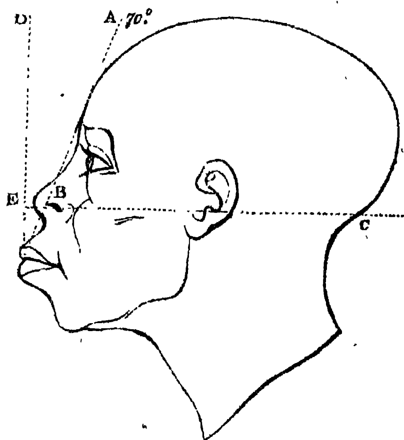
I may observe of Camper, however, that his object was rather to depict characters of countenance, as belonging to different nations and animals, than to connect these characters with any particular comparative qualifications; though, to a certain degree, this may be the effect of his system. For example, if he altered a sketch so as to make the facial line more perpendicular, and therefore to

increase the facial angle, he made it approach to the character of an antique; if he made the facial line more oblique, and therefore diminished the facial angle, he produced the countenance of a Negro. If he inclined the facial line still further back, he obtained the lines which mark an ape, a dog, or a bird. I will show you one of his sketches in which the facial line is made to incline forwards, so as to produce a facial angle of 100°.



This is the largest size which the artists of ancient Greece gave to the facial angle; and if it were still further increased, the head would appear mis-shapen, and unnatural. Another sketch of Camper's will show you the great contrast which the

Negro's face exhibits, in the retirement of the facial line, and the diminution of the facial angle, which is here only 70°.



HARRIET.

What a very extraordinary difference exists between those two characters of countenance. The projecting forehead of the one, affords a most striking contrast with the projecting jaws of the other; and it seems, indeed, as if the proportions of the face were quite reversed in them.

DR. A.

It is to be observed, however, that the ancients did not always strictly adhere to nature, in their delineations of the human countenance. In giving

a facial angle of 100° to their statues, they adopted an ideal standard of perfection, partly from a wish to remove, as much as possible, from the semblances of their great personages; the characters of the lower orders of the creation, and partly in order to transfuse into them, in an increased proportion, whatever might express intelligence or sublimity in the human species; which elevation and projection of forehead has always been supposed to do, from being regarded as indicating a greater than ordinary fulness of brain in that part.

CHARLES.

Are there any other peculiarities attaching to the antique head, than the elevation and projection of forehead, and the consequent large size of the facial angle?

DR. A.

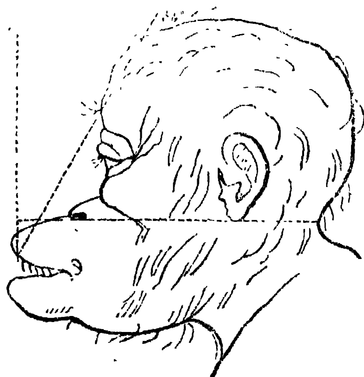
There is a greater breadth than natural in the forehead of the antique; the orbits are large; and there is an oval form of face, with which the cheek-bones of an ordinary head would remarkably interfere.

CHARLES.

Much of the character of the Negro's countenance seems to be derived from the projection of the jaw, independently of the forehead; and if we could suppose this feature to be altered, the face would not be very dissimilar to that of many Europeans.

DR. A.

Camper gives a plate in illustration of the very point which you mention, in order to show that the face of a European may be made a Negro's, or that of a Negro, a European's, by merely contracting or elongating the jaws and lips; and that thus the facial angle may be increased from 70° to 80° or 85°, while the forehead remained the same. You will be interested in my likewise showing you a sketch of the head of an ourang-outang, from Camper, in which the facial angle is 58°, owing, as you may observe, to the great projection of the jaws; for the forehead would not discredit a philosopher.



CHARLES.

The knowledge of the facial angle seems to be very well adapted to designating a certain shape

of face; and in man, to showing differences in the fulness of the forehead; but I cannot conceive what is to be gained by comparing this angle, in animals of different kinds; as if the ape, dog, and snipe had different degrees of intelligence, depending on the different magnitude of the facial angle, and that on the mere projection of the jaws. It seems to me, that the attributes of animals of different descriptions, and totally distinct habits and modes of life, hardly admit of comparison with each other; and that quadrupeds, birds, or reptiles, may have all the endowments which fit them, in the highest degree, for the purposes of their creation, without any reference to the comparative state of their facial angles. But I would beg to ask, whether, in children, the facial angle is not greater than in grown people?

DR. A.

Considerably; and this is to be attributed a good deal, to the difference which exists in the shape of the skull and bones of the face, at different periods of life. The prominence of forehead, and roundness and plumpness of face which distinguish infants, arise from the scantiness of the jaw, and the want of teeth; and gradually give way to a certain squareness of countenance, as soon as the jaws elongate, become larger, and obtain teeth. The cheek-bones then increase in magnitude; the eye-brows become projecting; and as the mass of fore-

head remains the same, the jaws are projected forward, and therefore alter the facial angle.

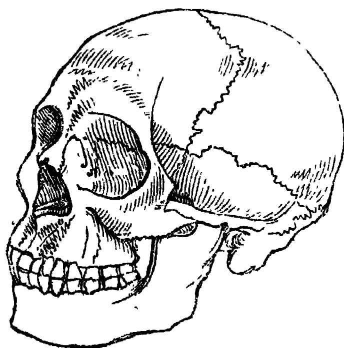
CHARLES.

Is the difference which occurs in the shape of the heads of inhabitants of different countries, natural, or does it depend on various habits of dress or management, which give a direction to growth, during the period at which the head may be susceptible of some change of form?

DR. A.

There seems to be a good deal of this the result of original natural conformation; but some nations, who admire flatness and lowness, instead of elevation of forehead, make an artificial pressure on the heads of their infants, by means of which the head is made broader, by the contents of it being thus directed laterally. This is the case with the Caribs, who were the original inhabitants of the West India islands, at the time of their discovery by Columbus; and who resemble, a good deal, some tribes who occupy the neighbouring continent, north-east of the sources of the Orinoko. This practice, however, does not appear to have been confined to them, but to have been employed in Peru, Brazil, and Lima; for more than two hundred years ago, it was prohibited by an edict of the synod of Lima; which shows that this custom was in use from the earliest periods of the history of these regions. Even in modern times, the prac-

tice is not extinct; for Messrs. Lewis and Clarke, in their Travels to the Source of the Missouri, mention that it is in general use among the natives west of the Rocky mountains, who are called flat heads by the nations east of them, among whom the fashion is totally unknown. These gentlemen have also observed the existence of the same habit among some other tribes of the native Indians; and they mention a female, in whom the depression of forehead was so great, as to form a straight line between the eyebrows, and the crown of the head. — The sketch which I now show you, is that of the skull of a Carib chief of the island of St. Vincent, from Blumenbach, which was taken up many years since, by desire of Sir Joseph Banks. The flattened forehead is very well designated in it.



It appears, likewise, that among some of the Asiatic nations, the practice of altering the shape of the skull by pressure, in different ways, at one time existed.

HARRIET.

We hear occasionally from travellers, of persons of extraordinary size. Is this a very usual circumstance? The freedom which there is, in savage life, from all sorts of restraint, must, I suppose, be favourable to height and vigour.

DR. A.

So it is often thought, but without proper foundation. Some nations, it is true, are remarkable for stature, as well as strength of body, as the Patagonians, the Caribbees, and the Cherokees among the Americans, the inhabitants of some of the South Sea islands, and the Caffres in South Africa: but savage tribes are, upon the whole, neither particularly distinguished for height, nor strength. Many, as the Esquimaux, are remarkable for diminutive forms; so are the Bosjesmans in South Africa; and the Mongols, Calmucks, and other tribes of Central Asia, are, in general, shorter than Europeans. The Virginian, or Kentuckian, is generally an overmatch for a native Indian; and the same inferiority of physical force was not only observed by the Spaniards, among the natives on the discovery of America, but has been

remarked by various travellers in the North American continent. M. Perou endeavoured to form an estimate of the comparative strength of the arms of 12 natives of Van Diemen's Land, of 17 of New Holland, of 56 of the island of Timor, of 17 Frenchmen belonging to the expedition, and of 14 Englishmen in the colony of New South Wales. He employed an instrument which he called a Dynamometre, or a measurer of power; which was so constructed as to indicate, on a dial-plate, the relative force of the individuals submitted to experiment.

The relative forces of the Frenchmen and the English, exhibited powers as 69 and 71; while the natives of Van Diemen's Land, New Holland, and Timor, were as low as 50, the two first, and 58 the last.

CHARLES.

The precarious subsistence of many savage tribes, must be very unfavourable, I should think, to vigour; and it is quite miserable to read of the difficulties which the Bosjesmans, and the natives of Van Diemen's Land and Terra del Fuego, have, in procuring a bare and scanty subsistence.

DR. A.

Something is unquestionably to be attributed to this cause; but much likewise to difference of race. We must, however, defer the prosecution of the object till our next meeting.

CONVERSATION III.

VARIETIES OF MANKIND CONTINUED.

CHARLES.

At the conclusion of our last conversation, you spoke of different races of men; but surely we are not to regard mankind otherwise than as descended from a single pair?

DR. A.

Certainly not; but then we have many varieties, as I have already mentioned, differing much from each other; but still not more than we continually find among many animals which were originally of the same stock.

CHARLES.

I have often thought how singular it is, that the various nations of the world, differing from each other so much in external appearance, should all of them have originated from two individuals. I suppose these differences are produced by the different effects of climate on the human body.

DR. A.

Such has been the opinion of many philosophers of great eminence, both in ancient and modern times; but yet it is not borne out by an attentive examination of facts.

CHARLES.

But is it not found that complexions darken as you approach the torrid zone, and that the darkest colour is in the warmest latitude? Thus we see, that the Norwegians and Danes are fairer than the English; the English than the French; the French than the Spaniards and Portuguese, and these than the Moors; while the Negroes in the burning regions of Africa are darkest of all? We even observe, that in this country, exposure to the sun darkens the complexion; and a European who is much abroad, acquires an approach to the colour of the inhabitants of his adopted residence.

DR. A.

You have put the case strongly; and we must admit, to a certain degree, the correctness of your facts, without however going to the extent of your conclusions. The influence of the sun is unquestionable on the parts which are exposed to it; but only on those parts. Captains Lewis and Clarke were so much browned during their expedition to the Missouri, as to be often taken, by the natives, for Indians belonging to hostile tribes; and it was only on showing the whiteness of their skin in such parts as were covered, that their suspicions were removed. In Lord Amherst's expedition to China, it was observed, that persons who were in the habit of working in the heat of the sun, with their bodies uncovered from their

waist upwards, became of a dark copper colour; but when they stripped, either for the purpose of bathing, or of going into the water in order to have a better view of the expedition, the comparative whiteness of the skin which was usually covered, gave them the appearance, at a distance, of wearing light-coloured pantaloons. In all these instances, when the rays of the sun heighten the usual complexion, the effect goes off, and in time the usual colour is resumed; while those who are not so exposed, as women and children, remain of the proper colour of the race.

SOPHIA.

But may not the long continued operation of such a cause, in time produce on their successors effects which would not be fully produced on the individual? I think I have read of a colony of Portuguese who settled on the coast of Africa three hundred years ago, and whose successors have now the complexion and features of Negroes?

DR. A.

You are quite right in your recollection of this statement; but then, unfortunately for the reasoning, the change was produced in consequence of continually marrying with the natives; and it would be very extraordinary, if, in the course of three hundred years, a complete assimilation with the natives should not in this way have been produced.

SOPHIA.

But is it the fact, then, that when persons are transplanted into a very different region, whether from a colder to a warmer, or from a warmer to a colder latitude, their successors will remain of the same colour as their original parents?

DR. A.

This seems, from a very extensive deduction of facts, to be the case. I have already noticed the small stature, and olive, or swarthy complexions of the Laplanders and Esquimaux, which evince their Mongolian descent, though the Norwegians or Americans are their immediate neighbours, who live in a latitude not materially different from them. Europe itself, in its subdivisions of inhabitants, affords a striking example of the continuance of the different character of its inhabitants from the earliest periods. The Celtic, the German, and the Sclavonic races, have all of them preserved the great distinctions of physical character, which they are described to have had at the time of Cæsar and Tacitus.

HARRIET.

But are we enabled to recognise, at the present day, any of the descendants of those ancient people?

DR. A.

The Celtic race occupied the Western parts of E[illegible] and its decendants, with the characteristics of [illegible] hair, and rather brown skin, still occupy

France, Spain, Portugal, and Italy. The Ancient Britons, the Gaels, the Irish, the Scotch, and the Manx, were a part of the same people; and it is said that vestiges of the same character are to be still found among them.

CHARLES.

Perhaps the designation of Dhu, or black, may be given to those tribes of Highlanders who possess this character in the most marked way.

DR. A.

Not improbably. The German race have, as their descendants, the Swedes, Norwegians, Iceanders, Danes, the inhabitants of the various parts of Germany, the English, and the Lowland Scotch; and the fair complexion, blue eyes, and yellow, or reddish hair, have passed on from ancient to modern times.

But the eastern parts of Europe were anciently, and still continue to be, occupied by people of a darker complexion, and of Sclavonic origin, as the Poles, Croats, Bohemians, and Bulgarians; which is the more remarkable, because these nations are close neighbours to the Germans, who have ever preserved a very different character. This is likewise the case with the Russians, with the exception of the peasantry in the North, who have frequently light brown, or red hair.

The gipsies afford a remarkable example of the force with which original characteristics adhere to the human body, under every change of climate.

Those people have been, for centuries, dispersed over every part of Europe, distinguished by colour, contour of features, and language, from the nations with whom they lived. They appeared in Europe about the beginning of the fifteenth century, and their origin was long unknown; but at length it has been ascertained, in part from colour and bodily formation, but principally from the affinity of language, that they sprang from some of the castes into which the Bazeegun Hindoos are divided. The gipsies are called the Siseeh Hindu, or Black Hindoos, by the Persians; and though there is some alteration of character, of countenance, and complexion, among the gipsies of the present day, owing in part, perhaps, to intermixture with foreign blood, yet they are occasionally seen with very dark complexions, and with every appearance of Oriental origin.

SOPHIA.

Do we find in countries where the inhabitants are usually dark coloured, that the light complexion is preserved for long periods of time?

DR. A.

In the island of Sumatra, children born of Europeans, are as fair as those born in the country of their parents; and so their successors have continued to be. On the other hand, the children of Negroes remain as black as ever. The same happens in the West Indies; and to show that

the effect is not lost, there are some families in Jamaica, whose predecessors left England at the time of the grand rebellion, and yet they continue to be as white as Europeans. A similar circumstance has been mentioned of the descendants of Spaniards in South America. The Anglo-Americans have likewise made no approach to the colour of the American Indians, however long may have been the period since they have quitted Europe.

CHARLES.

But do not the Jews, who are diffused over every part of the world, and whose religion prevents them from intermarrying with any but their own race, acquire the colour of the inhabitants where they dwell?

DR. A.

This is a mistake; they become brown, by exposure, as Europeans do; but their children are born fair, and the black colour of the hair, and the peculiarity of countenance, are preserved, in all parts of the world, in remarkable purity. There is a very curious example of the steady adhesion of such characteristics, mentioned by the well-known traveller in India, the Rev. Dr. Claudius Buchanan. He states that at Cochin, on the Malabar coast, there is a settlement of Jews, who, it appears by their records, migrated to India soon after the destruction of the temple by Titus Vespasian, and

who resemble the European Jews in complexion and features. They have kept their race distinct, and are called white, or Jerusalem Jews. There is, however, at the same place, a tribe of Jews, whose ancestors intermarried with the natives, and who have, in consequence, acquired the Hindu complexion and features. They are called black Jews, and are regarded as an inferior cast.

CHARLES.

When intermarriage takes place between whites and people of colour, and this goes on in either direction, the offspring will, I suppose, in a very few generations, acquire the full white, or black colour, as the case may be.

DR. A.

The period at which the complete change will be effected, is pretty well known in the West Indies and Spanish America; and there are particular terms, by which all the intermediate shades of colour between black and white, are designated. For instance, a child born of a Negro and European is called a Mulatto, and has equal parts of white and black blood. A child born of a European and Mulatto is a Terceron, and has three-fourths white, and one-fourth black blood. A child born of a European and Terceron is a Quarteron, having seven-eighths white, and one-eighth black blood. And one born of a European and

Quarteron is a Quinteron, having fifteen-sixteenths white, and one-sixteenth only black blood, and is considered as white by law, and free.

On the other hand, if a Mulatto intermarry with a Negro, the offspring darkens in the same proportion as it becomes fairer if the marriage was with a European; but the first step only has a name, the Griffo or Zambo, which has three-fourths black, and one-fourth white blood. Humboldt states, that in Spanish America, the greater or less degree of whiteness of skin decides the rank of an individual in society. A white who rides barefoot on horseback, thinks he belongs to the nobility of the country, and will often say to a great man, if he have a dispute with him, Do you think me not so white as yourself? It becomes therefore an interesting object, to estimate accurately, the fractions of European blood which belong to the different casts; and in Spanish America, they have numerous denominations for the offspring of Indians, as well as Negroes, with Europeans; and every person is so jealous of the honour of his tribe or cast, that if, through inadvertence, you call him a degree lower than he actually is, he is highly offended. It sometimes happens, that families suspected of being of mixed blood, demand from the high court of justice, to have it declared that they belong to the whites;

which, when they are rather swarthy, is termed "getting themselves whitened." When the colour of the skin is rather too repugnant to the judgment demanded, then the petitioner is satisfied with an adjudication, "that he may consider himself as a white."

SOPHIA.

You have, I think, very clearly shown, that the influence of climate does not produce any very essential differences among mankind, and cannot therefore give rise to the varieties which we observe among them; but I am exceedingly anxious to know on what those differences depend.

DR. A.

This is a very curious and interesting problem, and one which cannot, in every respect, be satisfactorily answered. There are, however, several important particulars known relative to this subject.

We have seen that the differences which climate produces in the colour of the body, wear off, or terminate with the individual: they are not capable of being transmitted to the offspring. Whatever effects art or accident may produce on the individual, are personal, and go no further; for otherwise we should see, that all those changes and mutilations, which the perversities of fashion produce, both on man and other animals, in all parts

of the world, would form permanent varieties among them. Thus the flattening of the heads among the Caribs, the contraction of the feet among the Chinese, the elongation of the ears among some, the perforation of the nose and lips among others, require all of them to be repeated on every individual, when such fashions are to be kept up. In the same way among animals, docking and cropping make no alterations in the tails and ears of the breed; and it is fortunate that it is so; for otherwise we should have the beauty of natural shape, permanently superseded by the wildest aberrations of vitiated taste. When, on the other hand, there is any peculiarity of form born with the individual, such peculiarity is capable of being transmitted to the offspring; and though we cannot trace all the steps by which changes are carried on, until they arrive at the production of permanent varieties, yet we can in many instances. Naturalists suppose that our sheep, our dogs, and our horses, were severally derived from one original stock; and yet what great variety there is in the respective breeds, and how separate they continue, provided they are kept distinct. We can even contrive to have the advantages of particular breeds blended for particular purposes, if we so wish it; and hence the permanent improvement which has been made among many

breeds of animals, and especially sheep, of late years, by agriculturists in this country.

CHARLES.

I can easily conceive that a mixture of breeds which already exist, may, in time, produce an union of the excellencies of particular ones; but are instances known of entirely new varieties being formed? for we must look, I presume, to such occurrences, to throw light on original differences in the same breed.

DR. A.

We have a very curious and well authenticated instance of a new breed of sheep occurring in America, from an accidental variety which appeared in a flock in New England. The characteristic of this variety was very short legs, particularly the fore legs, and a bend in the middle of them, somewhat like an elbow. Now, as the fences in New England were low, and were of wood or stone, it was thought desirable to have sheep which could not readily get over them. Breeding from this animal was therefore encouraged, and a flock of this breed, called ankon, from a Greek word signifying elbow, was in a few years obtained. — The Dorking fowls afford an example of a supernumerary claw being peculiar to one particular breed; and there are various other

striking peculiarities in different breeds of the common fowl. Some are very large, others dwarfish, as the Bantam; some have double combs; some are tufted; some are without rumps; and there is a very curious variety in Padua, in which a sort of appendage to, or dilatation of skull exists, in the upper part of the head.

CHARLES.

I suppose Albinoes are perpetuated in a similar way, among such animals as exhibit this peculiarity?

DR. A.

Exactly so; and we even observe in mice, the immediate occurrence which, as in the ankon breed of sheep, produces so remarkable a change in the character of the animal; for mice, when confined in dark places, have been found to produce a white breed with red eyes: and this character would go on, until interrupted either by crossing, or by a new occurrence in some of the future progeny. The Albino variety is very abundant among animals, and the white rabbit is a familiar example in this country. Almost all animals exhibit occasional varieties of the same kind. Thus they occur in cats, dogs, oxen, asses, sheep, and hogs, among the domesticated animals: among monkeys, squirrels, rats, hamsters, moles, opossums, weasels, martins, and polecats, of which last the common ferret is

supposed to be the white variety. They are likewise occasionally found in the buffalo, roe, camel, elephant, rhinoceros, stag, and jagen of Mexico; in the common bear; and in the badger and beaver. Albinoes have been found also among various species of birds; as crows, blackbirds, Canary birds, partridges, common fowls, and peacocks, having their feathers of a pure white colour, and their eyes red.

CHARLES.

Circumstances of deviation from usual structure must doubtless be found likewise in the human race?

DR. A.

Many peculiarities have been observed in them, as well as in the brute creation, which are capable of being perpetuated. Family likenesses are a familiar example: so is hereditary stature, whether large or small; and it is curious how long peculiarities of features may continue in the progeny. The thick lip, introduced into the house of Austria by the marriage of the emperor Maximilian with Mary of Burgundy, is visible in their descendants, even after a lapse of three centuries. Many instances have occurred, both in ancient and modern times, of peculiarities of structure being handed down from the parent. Thus the occurrence of six fingers, or six toes, is not uncommon. Such

persons were called, among the Romans, sedigiti, or sedigitæ, six fingered men or women. Sir Anthony Carlisle has recorded the transmission of such a variety for four generations.

I met myself, some time since, as you may recollect my mentioning to you at the time, an Irishman from Killarney, who had a thumb, and only two fingers, the third and little finger, on each hand; and only the large and small toe on each foot. The two fingers were united with each other; were permanently bent inwards; and were anchylosed, or stiffened, at the second joint, so as to have no motion in it. The metacarpal and metatarsal bones (those to which the fingers and the toes are united) were covered with integuments, which had not the smallest appearance of cicatrix or scar, to give any idea of the fingers or toes having ever been removed. This person's grandfather had one thumb on each hand, and no fingers; his father was like himself, both as to toes and fingers. He had many brothers and sisters, none of whom had any peculiarity; and of his own children (of whom there had been fifteen, though three only were living) the eldest son was the only one who had any peculiarity, and he wanted the middle toe on each foot.

The transmission of a peculiarity, for no less than nine generations, is mentioned as having occurred at Iver, near Uxbridge. The mother and several children had only the thumbs perfect; and

instead of fingers, they had only the first bone of each finger, and the first and second bones of the third finger of the left hand. The fingers had no nails. Such was reported to have been the state of the family, with slight variations, for nine numerous generations of their immediate ancestors; and it was observed by the mother, that the females only of the family, transmitted this peculiarity. No great inconvenience was stated by her to be felt from the want of so many joints, as the advantage of perfect fingers had never been experienced.

HARRIET.

Since peculiarities of form are so easily produced and transmitted, the same, I suppose, may happen with diseases, or tendencies to disease?

DR. A.

I have no doubt that tendency to disease, as depending upon a certain constitution of frame, may be handed down from parent to child; and some instances have been stated of diseases themselves, being so transmitted. There is no question, from what I have mentioned to you, that various malformations are also capable of transmission; and the same has likewise occurred, in numerous instances, of defects in structure, affecting function, and therefore amounting, to a certain extent, to disease. This has been the case remarkably with cataract, and some other defects of vision; and from the

circumstance of several individuals in the same family being frequently deaf and dumb, it is very likely that a tendency to this lamentable deprivation of sense, may be found to exist in particular families.

I have already mentioned to you the accidental occurrence of Albinoes in the human race, and how readily similar varieties are produced in other animals. Among all the nations of the world, this peculiarity is found to take place; but in many regions, there are particular tribes of Albinoes, which preserve their characters unimpaired, while they continue to intermarry with each other; and they are most frequent in those countries which are inhabited by a dark coloured race.

An Albino race has been long known among the copper coloured Americans of the Isthmus of Darien. Their bodies have been described as milk white; their eyes as red and tender; and they were called moon-eyed, because they were best able to see in moonlight, during which they were active and lively, though they were dull and sluggish during the day. They amounted to about a couple of hundred, when the account was first given of them, more than a hundred years since; and were more delicate than the other natives, by whom they were not much esteemed, being considered as something monstrous.

Captain Cook saw a few Albinoes at Otaheite; and in Java, Ceylon, and the neighbouring islands, as well as the continent, they are well known, and are termed Chakrelas or Cockroaches. They are viewed with horror by the Hindoos; and at their death are cast on a dunghill, or are left to be eaten by wild beasts.

In Africa, Albinoes frequently occur among the Negroes, though there does not appear to be any particular race of them; but even at Darien, now and then black children arise from Albino parents. There seems, upon the whole, to be rather a defect of general vigor in the Albino, connected, in some degree, with the want of the peculiar secretion on which colour depends. White hairs are often regarded as indicative of want of power; which is the case with white legs in horses.

I have already observed, that the hairs which are supplied, in this animal, in cases of injury, are grey; and that animals in high latitudes become white in winter, from a temporary defect in the secretion of colouring matter, which seems to be interrupted by cold; in old age this effect is connected with diminution of general vigour, and is permanent.

HARRIET.

Are we to regard the early occurrence of grey headedness, as a proof of less than usual general

strength? we very often see grey hairs among very young, and very strong people.

DR. A.

In such cases, I should only view it as a peculiarity of the part connected with the production of colour, and nothing more.

SOPHIA.

I have sometimes seen very fair young people with silvery locks, but nothing peculiar about the eyes. They are, I suppose, an approach to the Albino?

DR. A.

Certainly; and such an approach is very frequent, both among men and animals, and is continually observed among rabbits.—But one of the most remarkable instances which the history of mankind affords, of the production and perpetuation of an extraordinary deviation from what is usual in the human race, is afforded by a family whose case I have already alluded to; and you will be interested in hearing something more of it. In the year 1731, a boy of fourteen, named Edward Lambert, from the neighbourhood of Euston Hall, in Suffolk, was exhibited to the Royal Society, all whose body, except the face, the palms of the hands, and the soles of the feet, was covered with a dark brown thick case, exactly fitting every part of his body, made of a rugged bark or hide,

like united warts, callous and insensible, and in some places covered with bristles, which rustled like those of the hedgehog or porcupine. This curious covering was shed and renewed annually. He was afterwards exhibited in London when he was forty years of age, under the name of the Porcupine Man. He had had six children, in all of whom the same peculiarity of integument began to exhibit itself about nine weeks after birth. One of them only was living. Many years afterwards, about the beginning of this century, John Lambert, aged twenty-two, and Richard, aged fourteen, grandsons of the original Porcupine Man, were exhibited in Germany, and a minute account of them, with plates, was published by Professor Telesius.

It is clear, therefore, that if such a variety had occurred in a different period of society, and under circumstances conspiring to favour its distinct perpetuation, races of men might have been found, much more different from any yet known, than any of the present varieties of mankind are from each other. It is rather singular that more has not been heard of this family; for the elder brother was married, and his wife was pregnant at the period mentioned.

CHARLES.

But all these differences which you have mentioned in man and animals, relate to the production

and perpetuation of something defective, or unnatural in structure or appearance. Are we then to suppose, that the most perfect form of man, the Caucasian, was the original one, and that all the varieties which occur among mankind, have been produced by accidental differences, which have been kept up and perpetuated in their descendants?

DR. A.

The subject is full of difficulty and obscurity, as you may suppose, when I tell you, that some very ingenious men are of your idea; while others, from the analogy of animals in which changes of colour usually take place from darker to lighter tints, suppose that the primitive stock of men were black, and that it was by gradual improvements in this race, that the more perfect varieties of form have arisen.

HARRIET.

This would not have been a very favourable theory for Milton, whose descriptions of hyacinthine locks and golden tresses, and of all those circumstances of male and female form and complexion, in which we consider beauty to consist, must have been superseded by pictures of curly hair, thick lips, and sable visage.

DR. A.

And yet ideas of beauty vary very much among

different nations; so that if Milton had been an Ethiopian, or a Chinese, his descriptions would have been a little different from what, as a European, he made them.

It is impossible to ascertain the original form of the various breeds of animals which now fill the earth, or to trace the changes by which a difference in character has been produced among them. Much of what is stated by naturalists on these subjects, however probable, is, to a certain degree, hypothetical; and we must very generally be satisfied with analogies instead of proofs.

That nature delights in variety, is very apparent; for of the myriads of human beings who have appeared on the face of the globe, not one has ever been precisely alike in form or features. While, therefore, there is a general form and appearance adhered to in the succession of the human race, there is a certain latitude afforded for changes among them, though we know not to what extent this may go, or by what progression the original form of our first parents should, in the course of ages, have deviated into all the varieties which at present distinguish mankind. We have, however, gone rather further than was my intention, into the natural history of man; though I should hope, that the general view which I have given you of this subject, and for much of which I am indebted to the able works of Mr. Lawrence and Dr. Prichard,

may open to you a new source of interest, both in reading and observation. I must, however, before I quit this topic, advert to a cause of difference among men, as well as other animals, which I have not before noticed, and which will go a little way in answering the question proposed by you; I mean domestication, and civilization.

CHARLES.

Do you mean that actual corporeal differences are produced by those states? I can easily conceive that the mind may be altered, and the temper softened and improved by man being civilized, and animals domesticated; but I cannot understand how the effects can go further, so as to alter or modify external appearances.

DR. A.

I have already mentioned the opinion of naturalists as to the origin of many of our domestic animals. Our sheep, for example, have been said to have their original ancestor in the argali or moufflon, which is a bold, fleet, active animal, with horns, hardly resembling, in any of its characters, the timorous, dependent creature which is so useful to us, and which lives by our protection. So the dog, with its numerous varieties and properties, which fit it, in so many ways, to be the companion, the assistant, or the protector of his master, has been referred back to the shepherd's dog. These

changes, however, we cannot trace; but the domestic pig has been variously altered, in the various regions where it has been domesticated, both in the form and colour of its body; and yet the wild boar, from which it seems very certainly to have derived its origin, possesses very much the same general character, wherever it is found. The pig, indeed, affords the best example of a well ascertained change, effected in no very long period, in the appearance of an animal. It was known that pigs did not exist in America at its discovery by the Spaniards; but they have degenerated into breeds very different from each other, and from the original stock. Some that were taken over in 1509 to the island of Carbaguo, then celebrated for its pearl fishery, degenerated into a race with toes half a span long: and those of Cuba became more than twice the size of their European progenitors. In Hungary and Sweden, large breeds are found with solid hoofs, which is a peculiarity that was known among the ancients, and occurs sometimes in England. In Guinea, the hog has long ears, couched on the back; and in China, a large pendent belly, and very short legs; while at Cape Verd, and some other places, it has very large curved tusks, like the horns of oxen.

It seems as if regular and improved nourishment, and protection from the inclemencies of

weather, occasioned a more luxuriant growth, and by this means a disposition to produce varieties, which did not exist in the original state of the animal, when its food was simple and unvaried, and in precarious and deficient quantities.

Cultivation, in the vegetable tribe, has a similar effect with domestication among animals; and hence, in culture, richness, change of soil, and attention to all the external circumstances which produce or maintain health, we have the source of the finer and more luxuriant forms, and of the more beautiful tints in the vegetable kingdom, which the florist admires, but which the botanist regards as mere monstrosities, as nothing more than specimens of unnatural, and uncurbed growth.

CHARLES.

Do you suppose that the breeds of pigs, which have been so remarkably changed, would, on being taken to a less rich climate, and more unfavourable, position, recover any part of their original character?

DR. A.

Certainly not. The character is stamped on the race, only to be altered by the appearance of new varieties. It is to be remarked, however, that such changes as climate produces, will, in the course of time, and by change of temperature, disappear. Thus some polar animals are white,

which, in a warm atmosphere, or by a change to one, would be coloured; and, in the torrid zone, the soft fleece of the sheep is lost, which would be recovered, if taken where its warmth is necessary as a defence against the weather.

Civilization produces, among men, what domestication does among animals; and, indeed, a change from a savage, to a civilised state of existence, may, from the influence of moral causes, be fairly expected to be greater among the former, than the latter. I shall mention a few of the more striking instances, in which a certain degree of civilization, seems to have a certain physical effect on the body. The inhabitants of New Zealand, in the Pacific Ocean, all of them very much resemble the negro in colour, hair, and form of head. The Society Isles are peopled by a tribe of the same race which furnished the population of New Zealand; and the lower people resemble the New Zealanders in complexion and appearance; but the higher classes are gradually getting a fairer skin, and some of them are even approximating, in complexion and hair, to the German, or Teutonic race. It has been observed, too, that in the United States of America, the field slaves, who live on the plantations, retain pretty nearly the rude manners, and much of the structure and appearance of their original ancestors. On the other hand, the domestic servants, who

are treated with lenity, and enjoy much of the comforts of their master's house, have some alterations of physical form and appearance produced in the third generation; the nose becomes raised, the mouth and lips diminished in size, and the hair long.

CONVERSATION IV.

OF THE BONES.

DR. A.

After having explained to you the nature of the integuments, and given you an account of some of the principal circumstances relating to external form and appearance, I shall endeavour to make you acquainted with the parts which form the foundation of the body, namely, the bones.

These are intended by nature to give solidity to the frame, and to afford a ready means of insertion for the muscles, or those parts which are concerned in motion. They likewise protect, in various instances, important parts contained within them; and, by a happy adaptation of their extremities, in the joints, allow all those changes of position which are continually necessary to us.

HARRIET.

But would you not find it more convenient, after treating of the external parts of the body, to go to the inferior parts in succession, and to arrive last of all at the bones, as the basis?

DR. A.

It is exceedingly difficult, in an endeavour to

make a new subject familiar, to connect all the parts naturally and intelligibly with each other, so as neither to omit what is necessary for illustration, nor to anticipate information prematurely. I would say, however, that as the muscles form the great mass of the body, under the integuments, and as they lie upon, and are connected with the bones, and have their mode of action very much directed by them, it is rather more convenient to treat of the bones in the first instance, though the consideration of them, and the muscles, must be necessarily a good deal connected.

The bones then form the foundation of the body; and, besides being a basis or ground-work for the soft parts, are intended, as I have already intimated, to inclose and support some organs, which are of the first importance in the animal frame.

SOPHIA.

I recollect seeing, some years since, a skeleton at a medical friend of yours; but I was so much alarmed at the sight of it, that I was unable to attend much to its structure.

DR. A.

And yet every museum of natural history contains, now-adays, skeletons, both of man and other animals; and all who wish to enjoy the beauties of animal structure, and are desirous of becoming acquainted with many of the most curious

of the works of the Creator, will find their account, in overcoming the reluctance to inspect any thing which has actually belonged to the animal creation. But though you may, perhaps, still shudder at a real skeleton, you will not be alarmed at drawings of one, on which I can point out much of what will illustrate the subject of our conversation.*

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* EXPLANATION OF PLATE I.

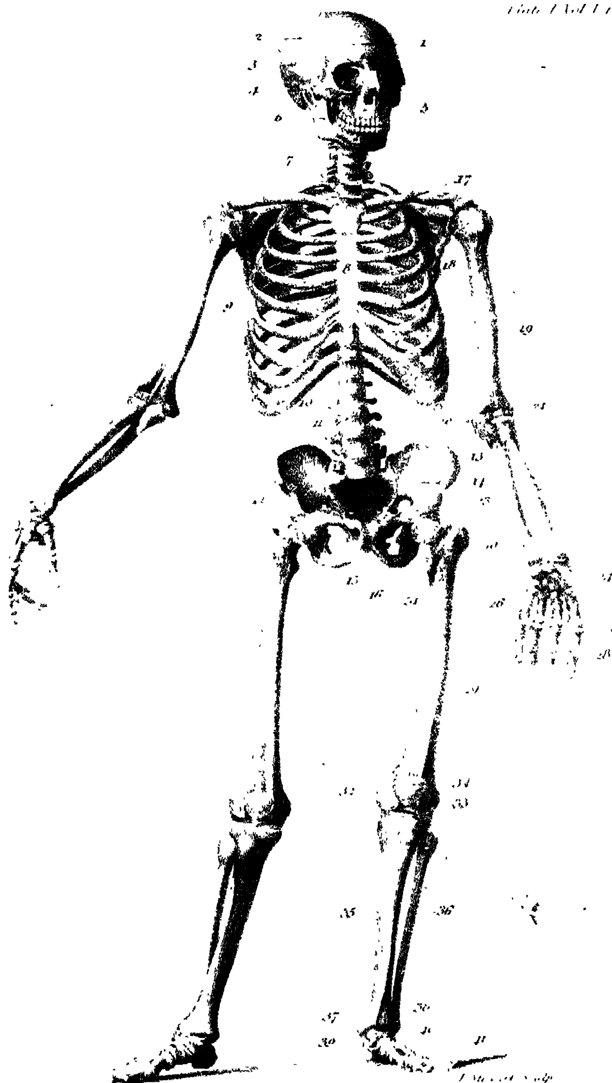
BONES OF THE HEAD AND NECK.

1. Frontal bone.
2. Parietal bone.
3. Temporal bone.
4. Malar, or cheek-bone.
5. Upper jaw.
6. Lower jaw.
7. The seven cervical vertebræ, or bones of the neck.

8. Sternum, or breast-bone.
9. Seven upper or true ribs, so called from being united to the sternum.
10. Five lower or false ribs, from not extending to the sternum.
11. Five lumbar vertebræ, or bones of the loins.
12. Os sacrum, or sacred bone, from its being used in sacrifices.
13. Bone forming the pelvis with the os sacrum, and called os innominatum, or nameless bone. It is divided into,
14. Hip bone, or os ilium;
15. Os pubis;
16. Haunch bone, or os ischium.

UPPER EXTREMITY.

17. Clavicle, or collar bone.
18. Scapula, or shoulder blade.
19. Shoulder bone, or os humeri.
20. Its inner eminence, or condyle.
21. Its outer eminence, or condyle.



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You see that the skull or cranium [Pl. I. No. 1—3. and Pl. II. No. 1, 2.] which contains the brain, is fixed at the top of the vertebral column, or

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22. Radius.
23. Ulna.
24. Wrist, or carpus, composed of many small bones.
25. Metacarpal bone of the thumb.
26. Metacarpal bones of the fingers.
27. Thumb.
28. Fingers.

LOWER EXTREMITY.

29. Thigh-bone, or femur.
30. Trochanter major, or larger process of the thigh.
31. ——— minor, or lesser ditto.
32. Internal condyle.
33. External condyle.
34. Patella, or knee-pan.
35. Tibia.
36. Fibula.
37. Inner ankle.
38. Outer ankle.
39. Heel, or os calcis.
40. Metatarsal bones of the toes.
41. The toes.

PLATE II.

BACK VIEW OF THE HEAD AND NECK.

1. Parietal bone.
2. Occipital bone.
3. Malar bone.
4. Lower jaw.
5. Cervical vertebræ.

THE TRUNK.

6. The ribs.
7. The twelve dorsal vertebræ, or bones of the back.
8. Lumbar vertebræ.
9. Os sacrum.
10. Os coccygis, or small bone appended to the lower part of the sacrum; so called from its resemblance to a cuckoo's bill.
11. Os innominatum.
12. Os ilium.
13. Os pubis.
14. Os ischium.

bones of the back, [Pl. I. No. 7, 11. and Pl. II. No. 5, 8.] in the centre of which is a hollow space, destined for the reception of the spinal marrow, a substance which is a prolongation of the brain, and resembles it a good deal in nature and function.

At a little distance from the skull, commence the ribs, [Pl. I. No. 9, 10. and Pl. II. No. 6.] which are fixed behind, to the bones of the back, and the greater number to the breast-bone before; [Pl. I. No. 8.] Their curvature forms a cavity, which is called the chest, and contains the heart and lungs.

At the lower part of the vertebral column is placed a firm, thick, strong, and irregular bony

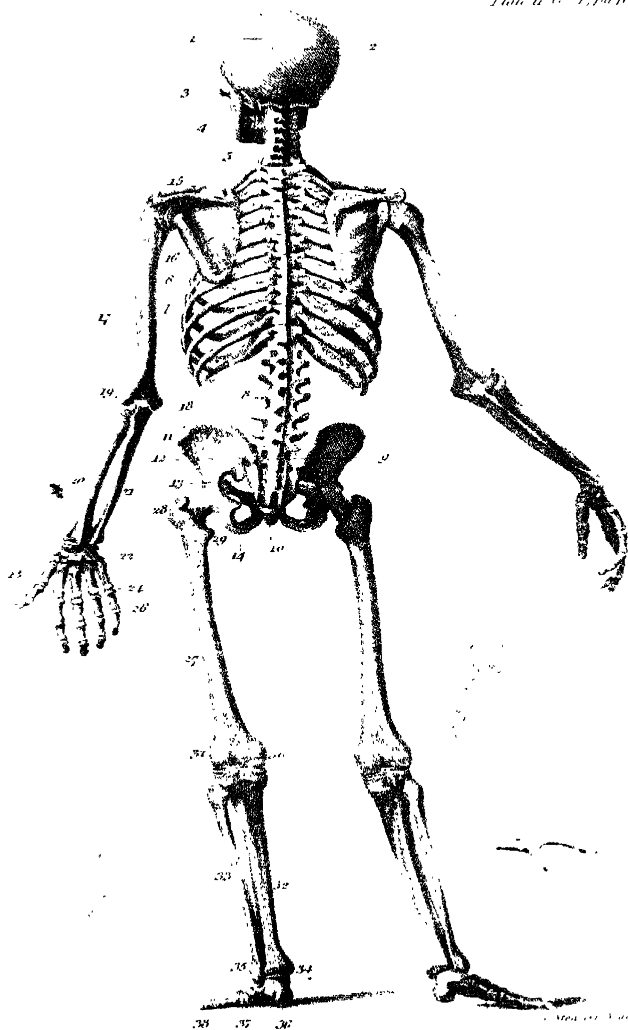
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UPPER EXTREMITY.

15. Clavicle.
16. Scapula.
17. Shoulder-bone.
18. Its inner condyle.
19. Its outer condyle.
20. Radius.
21. Ulna.
22. Wrist.
23. Metacarpal bone of the thumb.
24. Metacarpal bones of the fingers.
25. Thumb.
26. Fingers.

LOWER EXTREMITY.

27. Thigh.
28. Trochanter major.
29. ———— minor.
30. Inner condyle.
31. Outer condyle.
32. Tibia.
33. Fibula.
34. Inner ankle.
35. Outer ankle.
36. Tarsus, or ankle, composed, like the wrist, of many small bones.
37. Metatarsal bones.
38. Toes.



structure, called the hips, [Pl. I. No. 12—16.; and Pl. II. No. 9—14.] which encircle a sort of hollow space termed the pelvis or bason, from containing the lower part of the intestines, and some other important organs.

At the upper part of the ribs are fixed the shoulder blades, [Pl. I. No. 18. and Pl. II. No. 16.] into which the upper extremities are articulated or jointed; and at the lower part of the pelvis are articulated the lower extremities.

By the front and back views, and the particular explanations which I have annexed to them, you will be able to form a general idea of all the most material parts of our bony structure.

HARRIET.

There seems to be a great difference in the degree of protection which is afforded to the contents of the head, and those of the chest, though one would think that the heart was one of the most important parts of the body.

DR. A.

So it is; but then in the chest, there is a certain motion required, on account of the alternate dilatation and expansion of the lungs by respiration, to which a fixed and unyielding cover would be totally adverse. The cover is, therefore, composed of separate pieces, with muscles interposed; and the

whole calculated for the degree of motion which the action of respiration requires.

The form, magnitude, and mode of junction of bones, vary, according to the design which they are intended to serve. Where length is required, with flexibility at particular parts, we have bones, like those of the arm and leg, of firm texture, with joints at certain intervals. In the hand and foot, there is, by means of the numerous joints of the fingers and toes, and of a curious mechanism of bony structure between those parts and the wrist and ankle, a facility given to the various important actions of the hand, and to the more limited motions of the foot.

In the back, great solidity is required, and the motion in any one part of it is very small. In some of the joints, the power of motion is in all directions, as in the shoulder and hip; while in the elbow and knee, there is only the power of bending or extending them.

HARRIET.

One feels, indeed, as if a greater latitude of motion, particularly in the knee, would diminish stability; and therefore it seems to be wisely intended, just to give the kind of motion which convenience requires, at the same time that the utmost regard is paid to firmness, and steadiness of position.

DR. A.

This is the object which nature has continually in view, in regulating the motions of the body; and the machinery employed is that which, in every way, is admirably adapted for the purpose.

The joints which compose the shoulder and hip, are of the description which is called, in mechanics, the ball and socket; and they are adapted to the exercise of motion in all directions. The hip, as it is used in supporting the weight of the whole body, is very deep-seated, and has every resource employed in it, for the purpose of giving it firmness, and preventing displacement. It is fixed in a deep groove, as you may see in the sketches, with the bony edge a little lower toward the inside, in order to admit of motion in that direction; and it is secured by large masses of thick muscles, which lie over it. The shoulder-joint, on the other hand, is superficial, and has a very shallow socket, so that its motions are among the most free and extensive of any joint in the body. To render them still more so, it is attached to the shoulder-blade, [Pl. I. No. 18. and Pl. II. No. 16.] a subsidiary bone, which lies loose over the back, so as to increase materially the latitude of motion of the arm. The shoulder-blade again is attached, by means of the collar-bone, or clavicle, [Pl. I. No. 17. and Pl. II. No. 15.] to the upper part of the breast, where there is a small joint, which may be

said to be a hinge, on which the whole arm moves. You will easily understand this by the sketches; and may, at the same time, readily feel on yourselves, how all the parts which I have just mentioned, are concerned in the motion of the arm.

CHARLES.

On putting the hand upon the collar-bone, and moving the arm, it is quite obvious, that the hinge at the breast, is very important for facilitating the motion of the arm; a circumstance which otherwise hardly enters into the contemplation. But in what way are the joints attached to each other? A workman uses some sort of pin to keep his joints together. Does nature employ a resource of this kind, or are the joints merely kept together by the muscles which surround them?

DR. A.

Nature employs what are called *ligaments*, or *binders*, for the purpose of attaching joints together; and there is one particular kind which is known by the name of capsular ligament, which is common to all joints. It is so termed, from its inclosing the joint in a kind of purse, or thin and firm membranous bag, which is fixed at a little distance from each contiguous extremity of every joint, all around the bone. In this way, it is clear, that the two extremities of bone are kept together by a contrivance, which leaves the motion of the

joint quite free. But this capsular ligament is not of itself sufficient for retaining the joints in their position, and giving sufficient firmness to their movements. There are other ligaments which go from one bone to another, and fix them securely together; and these generally have their names either from their shape, or their position.

CHARLES.

One sees in the joints which come under observation at table, that there is a gristle which covers the ends of the bones which are connected together; this is, I suppose, for the purpose of making them move easily upon each other.

DR. A.

Just so. These gristles are called *cartilages*, and are always employed to cover parts which are intended to move on each other. For a bone, however smooth it may be, is not at all adapted to move on a surface of bone; not only because it is rough, but because it is unyielding. A smooth surface of cartilage would not, however, of itself, answer the purpose of giving sufficient facility to motion. In the delicate movements of nice machinery, oil is employed to diminish friction, which must, from time to time, be renewed; or otherwise the machine will be retarded, or stop. Nature has wisely provided the cavity of a joint with a continual supply of a glairy fluid, or synovia, as it is called, which is

intended to lubricate the cartilages, and make the movements on each other as easy as possible. You will now see how important it is, that every joint should have a capsular ligament, because the synovia is thus prevented from escaping, which it must necessarily do, unless for such a bag as is thus afforded to it.

CHARLES.

What a beautiful provision this is! a sort of natural oiling, which is continually keeping the joints in a fit state for movement. The inventor of the patent axle-tree must have had this natural process in view, in devising his plan for preventing the necessity of frequently greasing the wheels of carriages.

DR. A.

Not improbably: but nature here does what art cannot effect; for she not only produces the fluid necessary for lubrication, but keeps it, by means of processes with which you will afterwards become acquainted, in a state of continual adaptation for its purpose.

I have mentioned that the shoulder-joint is lodged in a very shallow cavity, in order to allow of great freedom of motion. It is thus, however, more readily displaced; but the liability to injury which this circumstance, as well as its superficial position, produces, is a good deal diminished, by its being defended by projections of bone from the shoulder-

blade, as well as by a great thickness of muscle on its upper and fore part.

The elbow is a joint of a different character; and it resembles what is termed the hinge, in carpentry: the projecting parts of one limb, that which is called the fore arm, or lower arm, lodging into cavities made for its reception in the upper. The motion, like that of the common hinge, is only that of flexion and extension; and it has not only strong ligaments to bind the parts together, but is strongly guarded, as indeed many other joints are, by projecting bones, which are intended to ward off injury.

HARRIET.

The wrist seems to have a very extensive power of motion; but you do not mention it as having the ball and socket joint, like the shoulder, which I should have supposed it would have, in order to possess similar freedom of motion.

DR. A.

I have said that the shoulder is very easily displaced, a circumstance which, if it applied to the wrist, would deprive it of much of its utility; and nature has therefore employed a very beautiful contrivance, to combine latitude of motion with security. The fore-arm consists of two bones, the *radius* [Pl. I. No. 22. and Pl. II. No. 20.] and *ulna*. [Pl. I. No. 23. and Pl. II. No. 21.] These are fixed to the wrist or carpus, [Pl. I. No. 24. and Pl. II.

No. 22.] which, with the bones continuous with the fingers, and called metacarpal bones, form the hand. The articulation is of such a kind as to have the motion of the hinge, that is, to work upwards and downwards. This is effected by the hinge-joint; but in addition to this, there is a second and separate joint, for the purpose of admitting what is termed pronation and supination, that is, of allowing the wrist to turn round to a certain extent on each side, upon its axis, in order to raise or depress the palm of the hand. To effect this, the radius moves, laterally, on a little knob-like head of the ulna, and carries the hand round with it. But in order to facilitate the movement, it has likewise a certain motion of a similar kind, but in an opposite direction, at the elbow, where a knob-like termination of the radius, moves in a little canal in the ulna. You may readily perceive both those motions, in yourselves, by a little attention; and will easily see, that by means of pronation and supination, and the double articulation which I have mentioned, the wrist has all the security of the hinge-joint, with much of the latitude of motion of the ball and socket.

CHARLES.

There is a contrivance not very dissimilar, in the frame of the telescope, where it is necessary to raise or depress the instrument, as well as to move it to one side or the other.

DR. A.

The objects are a good deal similar in both cases; but there is one particular joint in the body, where the analogy with the telescope-joints is exceedingly close. I mean that of the head upon the spine, where, by a very curious mechanism, we have the vertical and horizontal motions in a very complete manner.

I have already mentioned that the vertebral column is exceedingly solid, with a very small motion only, in any one point. It is composed of very irregular bones, joined together by strong ligaments, but with the projections so fixed into each other, as to prevent the possibility of dislocation. This is very wisely ordered, on account of the substance which the vertebral column is intended to protect, viz. the spinal marrow; for the bones are so fixed together, as to leave a cavity open from the head downwards, through which the spinal marrow passes; and it is clear that dislocation could not occur, without entirely destroying the marrow, and interrupting the functions depending upon it. The motion of each bone upon another is very small and obscure; but it is assisted by a cartilaginous sort of substance, which lies between each joint, and which, by yielding to the different movements of the back, renders the power of motion a little more extensive, and at the same time more gradual and equable. This substance is a very peculiar one, and is not

strictly similar to any other in the animal frame. While it is yielding in its nature, for the purpose of facilitating and increasing motion, it possesses so much elasticity, as immediately to resume its usual state of expansion, on the muscular force to which it has yielded being removed.

CHARLES.

But it is curious that with the power which it possesses of yielding so readily, it should not give way, over its whole substance, to the weight of the body, and thus gradually diminish the power of yielding, when motion is wanted.

DR. A.

And so it does: we are rather shorter in the evening than in the morning, from the continued compression of this intervertebral substance during the day; and if it were not for the recovery of its elasticity during repose, we should experience the inconvenience suggested by you. But to explain the point which led to these observations, the head moves up and down, by its having a hinge-joint at the upper vertebra of the neck, the atlas, as it is called. In order to accomplish the rolling motion, a perpendicular projection exists in the second bone of the back, which is, from its resemblance in shape and magnitude to a tooth, called the tooth-like process, and is fixed securely by a ligament to a little notch at the fore part of the atlas. The

head with the atlas attached to it, works upon this tooth-like process, and thus obtains all the necessary freedom of lateral, and rotatory motion. You can readily understand how the head moves up and down, because it is by the common hinge-like movement; but it is more difficult to comprehend the mode in which the action of the head upon the tooth-like process, which I have just mentioned, is effected. You may, however, conceive how this takes place, by holding the fore-finger of your right hand perpendicular, and grasping it with your left hand. In this case, it is clear, that the left hand, with the fore-finger grasped in it, can be moved round in all directions on the right; and this may be a rough example of the way, in which the head moves on the tooth-like process represented by the fore-finger.

The head and hand, therefore, possess a similar freedom of motion; but it is accomplished by different means, and both of them in a way best adapted to the circumstances of the particular joint.

HARRIET.

But does this little elevated portion of bone give a strength to the joint, sufficient to prevent displacement?

DR. A.

It is to be remarked that the resting is perpendicular, so that the bearing is not upon the tooth-

like process, but the body of the bone; and to guard against lateral motion, which would break, displace, or injure this process, there is not only a very firm ligament to keep it in its place, and prevent its pressing on the spinal marrow, but there are likewise strong and firm ligaments to bind together the second vertebra, out of which the tooth-like process grows, to the atlas. There is also a very firm protection given, from the thick and strong layer of muscles and tendons, which take their origin from the vertebral column, and accompany it all the way down the back.

SOPHIA.

I suppose that some parts of the vertebral column have more capacity of motion than others; for in tumblers, I have often been surprised, and even distressed, at the twistings of form which they are able to make.

DR. A.

The neck and loins have more power of motion than the back; but still there is very little motion in each joint; and what there is, is much augmented by the compression capable of being exercised on the intervertebral substance which I have just mentioned.

There is another joint, which I may mention to you, the knee, which exhibits an example of great pains and attention bestowed on imparting to it strength, and the power of resisting injuries.

The thigh consists of one bone only, as you may see by the sketch; but the leg consists of two, the tibia, a large one; [Pl. I. No. 35. and Pl. II. No. 32.] and the fibula, a small one, [Pl. I. No. 36. and Pl. II. No. 33.] lying on the outside of it. These two bones are fixed very firmly together, and they are joined to the thigh-bone, at the knee, in the manner of a hinge; but to this they are not only united at the sides, by very powerful ligaments, but likewise at the very ends of the bones, by strong cords placed crossways, in the middle of the joint. A single cord, of a similar description, exists also in the joint of the thigh. The knee, too, is guarded in the front by the knee-pan, or patella, [Pl. I. No. 34.] which is intended to protect the edges of the joint, from the injury to which, unless for this appendage, it would be liable.

I have already mentioned to you, that the radius and ulna unite with the carpus or wrist, which, with the metacarpal bones, form the hand. The tibia and fibula, in like manner, unite at their lower part, with the tarsus or ankle, and this, in conjunction with the metatarsal bones of the toes, forms the foot. But the wrist and ankle, instead of consisting each of one bone only, are formed of several bones, so irregular in their shape, and so firmly united to each other, as to make displacement exceedingly difficult. These bones are, however, attached to each other in such a manner, as to

allow a certain slight degree of motion, which is obviously of great importance, both in the foot and the hand.

As it is my principal intention to communicate to you a knowledge of principles, and of some of the more important facts to elucidate them, it is not necessary to go further into detail with regard to this part of our structure. I would, however, merely advert to two sets of bones, which form a very important part of the body; namely, those of the head, called the skull; and those of the hips, or the pelvis, as they are termed, from containing various important parts within them, as a bason.

The skull was originally formed of many distinct pieces, which became joined by sutures, or a kind of zig-zag work, which in time became as solid as any other part of the bone, from the bony matter, at the place of junction, becoming firmly united. The hips, likewise, were formed originally of various separate bones, which became in time firmly joined together, and capable of supporting the great weight which they are intended to bear. They are fixed to the lower part of the vertebral column behind, and to the lower extremities before, so as obviously to be the material instruments of sustaining the principal weight of the body.

The sutures form a very curious mode of union, and one which is evidently applicable, in a very

admirable manner, to the junction of the bones. If you can suppose a small saw laid flat upon thin pasteboard, and the pasteboard to be cut, according to the marks which the teeth of the saw will make by a slight pressure, you will then have a sort of dove-tail work, by which each divided portion will accurately fit into the other. This very much resembles the juncture by suture, and it is beautifully adapted to the union of very thin surfaces.

CHARLES.

The points of union are by this means evidently much increased; whereas, in broader surfaces, where a larger front is applied, such a plan would be superfluous. But is the number of bones of the skull arbitrary, or does it follow a certain uniform division?

DR. A.

These bones are, with occasional trifling differences, the same in all skulls; and they are designated by particular well known names. The bone in the front is called the frontal bone; [Pl. I. No. 1.] the two immediately behind, the parietal bones, from being supposed to defend the brain, as a paries, or wall [Pl. I. No. 2. Pl. II. No. 1.]; that at the back of the head, the occipital bone [Pl. II. No. 2.]; the two immediately over the ears, the temporal bones, [Pl. I. No. 3.] These bones are all of them joined by sutures, which have also certain designations. That which joins the frontal

bone to the parietal bones, is called the coronal suture; that which joins the two parietal bones together, the sagittal suture, from being placed as an arrow (*sagitta*) on the curved coronal suture; the suture placed between the parietal and the occipital bones, is termed the lambdoid suture, from its resemblance to the Greek letter lambda, λ; and those which join the temporal bones to the parietal, to the frontal, and to the occipital bones, are termed the squamous sutures, from overlapping each other as a scale, instead of being dovetailed like the others.

SOPHIA.

Why are the bones at the sides of the head called the temples? There is a common idea, that a blow on them is more dangerous than at any other part of the head: is this correct?

DR. A.

Temple is an abbreviation of temporal; and they were termed ossa temporum, or temporalia, from tempus, time, because grey hairs were supposed to make their appearance first at this place, and thus to imply, that the effects of time were becoming visible. I am not aware of greater danger attaching to a blow on this, than any other part of the head; except in as much as a fracture, or other injury here, would be likely to be more deep seated, and to be further removed, therefore, from the reach of appropriate treatment.

There are two other bones which form the lower and front part of the skull, which are of a very irregular shape; these are the sphænoidal bone, from a Greek word signifying wedge, being thought to be fixed in the skull as a wedge; and the ethmoidal, from a Greek word signifying sieve, this being in the front, and perforated variously, for many important purposes.

CHARLES.

I am very anxious to know what bone is, or rather how it is formed; for I recollect having heard of its being composed of phosphate of lime, though I am at a loss to know how this particular salt furnishes such a singular substance as we see bone consists of.

DR. A.

The original state of the body is that of a soft kind of jelly, which contains the rudiments of parts, and in time acquires solidity, and that peculiar form which particular parts are destined to assume. The bones themselves, hard and substantial as they appear, were originally nothing more than soft pulp, contained within a membranous covering, which gradually became harder, and, at the proper period, acquired solidity sufficient for all the purposes of life.

CHARLES.

Do you mean, then, that there were in bones

intermediate states of solidity up to that of perfect bone?

DR. A.

Certainly; for the most substantial bone was, between its original softness and eventual solidity, in a cartilaginous state.

CHARLES.

Then I suppose bone is nothing more than hardened cartilage, and cartilage, hardened jelly.

DR. A.

This was an idea very commonly entertained by physiologists at one time, but it is totally incorrect; for the formation of the original jelly, or soft material of the cartilage, and that of the bone, are all different processes of the animal economy, depending on different actions of the vascular system. To understand this, however, it will be necessary to give you a slight sketch of the vascular system, and of the operations depending upon it; for though it would be more systematic to speak of these things separately, yet it is my plan to endeavour to make every thing intelligible as I go on.

The vascular system is a general term applied to the vessels, or tubes, which circulate the blood through the body, and by means of which its growth and nourishment are provided for. These tubes are called blood-vessels, and consist of arteries and veins. The arteries derive their origin

from the heart, and carry the blood over every part of the body; the large tubes being divided into smaller and smaller ones, until they are so small as to be incapable of being seen. The minute extremities of arteries are united to the minute extremities of other vessels, called veins, and these becoming larger and larger, at last form very large tubes, which bring the blood back again to the heart, from whence it set out, to repeat the same process of circulation. Now, the blood is the particular fluid from which every part of the body is formed, however different may be its texture, nature, and appearance.

SOPHIA.

But do you really mean to say, that our skin, flesh, and bones, are all formed of blood?

DR. A.

Not exactly of blood, but from blood; for the blood supplied by the food which we take into the body, contains the elements of all the particular substances of which the body is composed; and from it, by means of a process called secretion, and which goes on in the very minute vessels of the body, the particular substances, whatever they may be, are formed. Thus much it was necessary to anticipate, in order to keep up with our subject.

The soft jelly, then, which I mention as being the rudiment of the bone, was originally thrown

out by minute vessels; but in the course of time, and according to the wants of the system, the same vessels secreted cartilage, and afterwards bony matter itself.

The bony matter is deposited in a sort of net-work; and hence the appearance of spaces, when you examine bones, which are accidentally exposed. The net-work appearance arises from the original configuration of the material on which the deposit takes place, and which consists of what is termed cellular membrane, or a net-work of a very fine membranous substance. This, it is important to know, is universally diffused over every part of the body; it not only separates various parts, as the skin from the muscles, and the muscles from each other, but there is no minute subdivision of a muscle, which does not exhibit cellular membrane between its fibres. By this sort of configuration, connection takes place between the most distant parts of the body; and hence the practice among butchers, of giving a plump appearance to meat, particularly veal, by distending this particular substance with air; which is often done, likewise, to facilitate the separation of the skin. The cellular membrane assumes various appearances and modifications, and forms the frame-work, as it were, of all the various structures of the human body. This, therefore, is the frame-work of the bones, and with it is always contained a portion of animal

jelly, both which boiling will dislodge, and thus the earthy matter be left untouched. On the other hand, the action of acids will remove the earth of bone, and leave the membranous and gelatinous parts behind.

CHARLES.

There must obviously be a great deal of soluble matter in bones, not only from the effects which boiling has in extracting a large quantity of nutriment from such substances, particularly when high temperature is employed, but from many animals being able to procure from them so much of their subsistence. But do the proportions between the substances of which bone consists vary at different periods?

DR. A.

The younger the person is, the greater is the quantity of jelly; and in old people there is a much larger proportion of ossific matter, and, as it were, much less succulence of structure than in the young. Some animals have their bones composed entirely of cartilage, as the shark, skate, sturgeon, and all those fishes which are called cartilaginous; while the bones of other fish, of reptiles, and of serpents, are more than usually flexible, from the great quantity of gelatinous, and the small quantity of solid matter which they contain.

Every bone has a thin covering belonging to it, which adheres closely, and is called the periosteum,

or substance lying upon the bone. Within this covering, the substance forming the future bone lies, whatever its shape may be; whether round, as bones generally are, or flat, as are those of the head and some other parts of the body.

The vessels which circulate the blood in the jelly or cartilage, are, as I have mentioned, the means by which the bone is secreted; and the operation goes on in different parts of the bone, at the same time. The body of the bone has this process going on separately from its ends or heads; and it is thus wisely determined, because the body of the bone is required to take up as little room as possible, in order that there may be space left upon it, for the solid masses of muscle by which it is to be covered. The extremities of each bone are required to be larger, for the purpose of their being more conveniently joined to each other; and they do not require the same consolidation as the centres, because it is clear that any mass of muscle would interfere with the motion of a joint. We shall afterwards find that nature has provided for this point.

HARRIET.

You have thus shown us how bone is formed; but the jelly, and subsequently the cartilage, which precede the deposit of the bone, must have formed a solid mass, and bones have usually cavities in them.

DR. A.

The original mass of cartilage, and of jelly which preceded it, were unquestionably solid, that is, without cavity, and were equally diffused in the meshes of the network, or cellular membrane, which I have noticed; but the bony matter is deposited in such a manner in the large bones, as to leave a cavity, which still contains the original network, into which a fatty substance is thrown, which is distinguished by the name of marrow. Some animals, it must however be observed, have no cavities in the centre of their bones, such as the whale tribe, skate, and turtles.

The formation of cylindrical bones takes place so as to give them as much strength as possible in the smallest space. If they were entirely solid, they would be unnecessarily heavy; and if the materials were brought into smaller bulk, they would be weaker, because the strength of a bone is in proportion to the distance at which its fibres are from its centre.

The ends of the bones are formed distinctly from the bodies, and are separated by a sort of gristle; but in adult age, the union between their parts becomes complete.

In flat bones, as those of the head, there is, instead of a cavity, a sort of loose space, or lattice work, called diplöe, or meditullium, answering to the cavity of cylindrical bones.

CHARLES.

When a limb is broken, there is, I suppose, a similar process begun and carried on, to that which occurs in the formation of bone originally.

DR. A.

Very much so. The wounded vessels pour out a soft material, which, in time, has bony matter deposited in it, to supply the injury; but there is generally some irregularity of surface in the produced part, because the repair does not take place in a way equal to the original fabric. The new bone is called callus, and it has no cavity formed in it, as in the old.

SOPHIA.

I have heard sometimes of people's legs or arms not uniting after being broken. How does this happen?

DR. A.

There is, in such cases, a defect in the power of secreting bone, generally from some want of energy in the constitution, as it happens sometimes in old people; but there is likewise a disease in children, rickets, in which there is less power, in the constitution, of producing ossific matter. In some persons, without apparent disease, there is a constitutional tendency of this kind, which I have seen, in some instances, to a remarkable extent.—But if there is sometimes a deficiency in the power of

secreting bone, there is sometimes an excess; and it is a curious circumstance, that there is no vessel in the body which may not, some time or other, produce bone. The deposit of bony matter, in this case, frequently takes place on the coats of arteries themselves; and, in many instances, particularly when such a circumstance occurs in vessels near the heart, is productive of serious symptoms.

CHARLES.

I suppose the marrow is intended to transude through the substance of the bone, and keep it soft.

DR. A.

This was an old, but a very incorrect idea; for the vesicles in which the marrow is contained, will not, in their natural state, admit of any transudation. The marrow seems to have little more use than that of filling up, by a light substance, spaces, which it was important should not be filled with more solid matter. But it is to be observed, that it is not every animal which has marrow in its bones. In birds, the bones are almost all of them hollow, as you may see in giblets, but empty; that is, they are full of air, which enters them from the lungs; and thus adds to their buoyancy.

HARRIET.

There are two points relative to bones, which I cannot understand perfectly. I see how the found-

ation of a bone is laid, and how the bony matter is deposited; by which means it may be readily understood how a bone is formed of a certain size: but these bones increase, and I do not see what provision is made for this circumstance, since one can hardly conceive any thing like a process of stretching a bone, and at the same time adding to its bulk. The other point is, that, if the cartilaginous matter is deposited on the gelatinous, and the bony upon the cartilaginous, bones ought to consist of a mixture of all three substances; whereas in full grown bones, the whole is exceedingly solid, and exhibits little or nothing of either of the two first materials.

DR. A.

These are very natural observations; and in explaining the difficulties which you mention, I shall have an opportunity of noticing a very beautiful and important process in the animal economy.

I have already stated to you generally, that the body is supported by circulating vessels, which carry blood over every part of the body, and bring it back to the heart. Together with blood-vessels, there are also vessels which are termed *absorbents*, from their powers of absorbing, or taking up; and by means of their action, a continual removal of parts takes place, which have been formed by the operations of the circulating and secreting systems. These absorbent vessels arise in every part of the

body; and by the operation which they exercise on the one hand, owing to which the most solid parts are continually taken up, and by the agency of the secreting vessels on the other, which are continually depositing from the blood, and more remotely from food taken into the body, the substances of which the various organs consist, there is a continual process, uninterruptedly going on, of renovation and change of parts; by means of which nature not only provides for the proper materials of animal structure, but for their being kept in a state of health and vigour.

To apply these remarks to your first observation; the soft jelly, which formed the rudiment of the bones, is in time taken up by the absorbents, and is succeeded by cartilage, which, in its turn, is removed, and bone deposited: but though I mention the changes from jelly to cartilage, and from cartilage to bone, as gradual, yet it is to be remarked, that there is no period at which the absorbents are not at work, and removing the old materials, while the secreting vessels are renewing them, so as to keep the whole machine in continual order. Nature is thus in constant activity, and in constant change.

CHARLES.

This is really very wonderful; but does it not seem to be rather an unnecessary process, to build up, as it were, for the mere purpose of pulling

down; just as if an architect, after finishing a building, should set to work, curiously to remove stone after stone, with no other apparent view, than to supply, with the same material, the part which may have been removed?

DR. A.

The works of the architect, owing to the perishable nature of his materials, are liable to be continually affected by weather, and all kinds of accidents from without. He is therefore under the necessity of frequently going into a system of regular repair, by renewing what is defective, strengthening what is weak, and taking down, in order to build up with additional firmness. But with nature, the operation of consolidation and repair are simultaneous; for the process of renewal goes on so nicely in the most inward recesses of the body, as to leave no part without a continual circulation of new matter, and therefore of renovated strength and vigour, as long as the period of vigour is intended to continue. Absorption likewise provides for the growth of the body; for if nourishment merely furnished support, parts could acquire no additional magnitude, but would remain of the same size that they had originally. As absorption and nourishment, however, go on together, there is a continual means of increase afforded, while the necessity of increase continues; and this process puts at

an infinite distance, every thing of human invention or power. If an architect wishes to enlarge a room or a house, he must make an actual augmentation of feet or inches to the work already existing; if a machine is to be increased in size, its various parts must be taken to pieces, augmented, and strengthened, before it can be fitted for the additional work which it is intended to perform. The operation in the mean time is stopped: but in the works of nature, there is no cessation, no period of halting, or shutting up for repair; every process is simultaneous, and thus are not only nourishment and growth provided for, but also the removal of every thing which may be injurious or inconvenient.

HARRIET.

The process is most beautiful, and it is difficult to conceive any thing in contrivance so exquisite; and yet how little do we dream of such a continual series of interesting operations going on in the body.

DR. A.

Such is the fact; and the same beauty, the same adaptation, the same general harmony of usefulness, is manifested over the whole animal creation.

Before we take leave of the bones, I would just remark, that there is a certain analogy of structure among all animals which have vertebræ, and therefore a skeleton; but, in some animals, the

bony structure is on the outside of the body, as in all the testaceous tribes, which are enclosed in one or more shells; as the oyster, snail, whelk, &c.; and also in the crustacea, which comprise the crab, lobster, shrimp, &c.

SOPHIA.

But can the bony covering, under such circumstances, answer the purpose of an origin and insertion to the muscles?

DR. A.

In some of the testaceous animals, as the oyster, muscle, cockle, &c., there are muscles by which the animal opens and shuts its shells, or rather shuts them, for the opening takes place by means of an elastic ligament, on the power being suspended by which they are shut. Others of the testacea with one shell, the univalves, such as snails, for example, have muscles so connected with their shells, as to give the animal the power of thrusting out its body from the shell, and drawing it in again.

In all such cases, the principal part of the muscular structure exists independently of the shell; which is to be principally viewed as a defence to the animal. So it is likewise with the crustaceous tribe; and, in both them and the testaceous, there is a power of renewal in case of injury, which, in the former, not only goes to the shell, but likewise to the limb itself.

SOPHIA.

What, have such animals the power of regaining their limbs if lost?

DR. A.

Many of them certainly have: and lobsters and crabs are sometimes, after thunder storms, found to be entirely without their claws, which require some time for reproduction. The jar communicated to the water, and perhaps terror on the part of the animal, have the singular effect of making these creatures throw off their claws. A great gun fired by a ship of war will likewise do the same: and hence a threat of this kind will often bring an imposing fisherman to reasonable terms. The effort seems to be voluntary, for some of the younger of these animals will drop their claws, on an attempt to take them, without actual contact. The limb is forced off, as Dr. Macculloch has shewn, during violent extension, by means of a curious mechanical structure, with a loud crack. — In both the testaceous and crustaceous animals. the vessels of the surface have the power of throwing out, or secreting, the matter of the shell. Crabs and lobsters lose their shells annually, and seek retirement till the new shell is sufficiently consolidated; as they are aware of their defenceless state at such times. The shell is originally soft and membranous, and gradually obtains its proper thickness and solidity.

CONVERSATION V.

OF THE MUSCLES.

DR. A.

I MENTIONED to you, that an important use of the bones, is to afford a place of insertion for the muscles. These are the organs which are concerned in motion; and they make up a very considerable part of the mass of the body, particularly of the extremities. They are composed of bundles of fleshy fibres, bound together, and consisting of smaller and smaller bundles of fibres, connected by cellular membrane, and separable into fibres, as far as they are capable of being divided, or of being perceived, either by the naked eye, or by glasses. This fibre has been thought, by some, to be cylindrical, and to envelope a portion of pulp; while the nice microscopical observations of Bauer induce Sir Everard Home to suggest, that the ultimate fibre may be formed of a chain of globules of the blood, (which I shall have occasion afterwards to mention to you,) cohering together by an attraction between them, which takes place only when they are deprived of colour. — Microscopic observations have likewise discovered a globular structure in the cellular texture of the body.

SOPHIA.

I recollect the surprise which I felt, in our first conversation, at being informed by you that all the flesh of the animal body consists of muscle: but in what way are the different actions produced by muscles; for flesh, whenever I have happened to see it, (though I must own I have not very attentively observed it,) seems to consist entirely of one mass of uniform material?

DR. A.

If, however, you should remark more particularly than you have yet done, some of the joints which come to table, especially the round of beef, you will see that there are different divisions, having different appearances, and, with gourmands, varied degrees of excellence. These are different muscles of the animal, with the fibres cut transversely, which are prolonged to the particular parts which they are intended to move. — The action of a muscle consists in its shortening itself, and thus bringing the parts to which it is attached nearer to each other. This is called its state of contraction; and when it resumes its original state, it is said to be in a state of relaxation.

SOPHIA.

In shortening itself, a muscle, I suppose, swells up in the middle.

DR. A.

It swells up in the middle, and becomes rigid over its whole extent; but it does not occupy more space in the whole than it did before. If you bend your arm firmly, you will find a large and rigid muscle, occupying the front of the arm nearly to the bend of the elbow; and if you shut the jaws forcibly, you will feel a rigid contraction extending forwards from the angle of the jaw. In the one case, the biceps or bender of the fore-arm is felt; in the other, the masseter, or principal muscle employed in mastication.

CHARLES.

One can feel these actions very distinctly; but I observe that the lower part of the muscle of the arm, which you have just mentioned, terminates in a hard sort of cord, which may be felt extending itself to the upper part of the fore-arm.

DR. A.

This is called a tendon, or sinew; and it is fixed to the part to which you can trace it in the fore-arm. On the other hand, the upper part of the muscle is traceable to another tendon, or rather two tendons, which are implanted at the shoulder, and give the term of biceps, or double-headed, to this particular muscle.

CHARLES.

It is clear that, considering the position of these

muscles, a shortening of the biceps will bend the elbow joint, and a shortening of the masseter will shut the jaw; and I should think, by knowing the origin and insertion of muscles, that it will always be easy to determine their use.

DR. A.

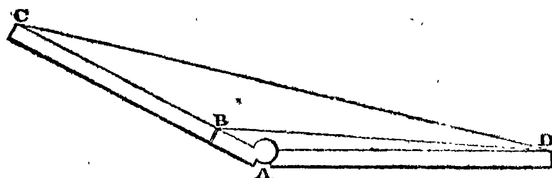
In a very considerable degree.

HARRIET.

I wish you could give us some little mechanical illustration of the action which you describe. I am not quite certain that I altogether understand it.

DR. A.

I think I shall be able to make it intelligible by means of a common two-foot rule, having a joint in the middle. If you suppose a rule of this kind to indicate the arm, fore-arm, and elbow, and I fix a piece of cord (at B) about two inches from the point (A), and bring it by the hand to a position (D), which we may suppose the shoulder, then it is clear that, if I draw the cord, I shall double up the rule, either wholly or in part, and thus imitate the action of bending the arm at the elbow. The cord here acts the part of a muscle; and must be drawn, just as much, in order to produce the effect of bending the joint, as the muscle must be shortened or contracted, in the bending action of the arm.



CHARLES.

It is exactly as you state; but yet with what a very little power the muscle thus circumstanced will act, when it is fixed so near the centre of motion. One would imagine that it was always an object with nature, to make the most of power; and to adopt the plan by which the greatest power would be most easily exercised.

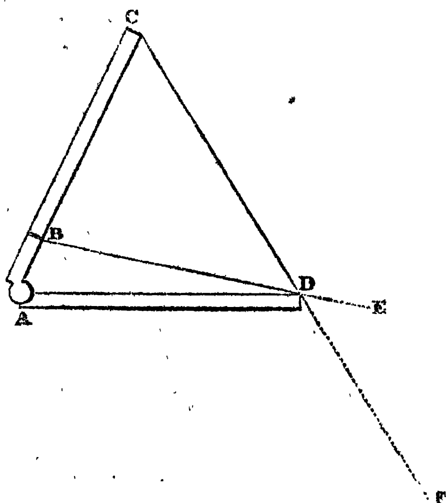
DR. A.

You are quite right in your conclusion, that there is a considerable loss of power by such a distribution of muscle as that which I have now noticed; and in works of human invention, the artist would aim at applying the power, at the greatest possible distance from the fulcrum, or centre of motion, in order to increase the effect. But then you must remark, that nature not only keeps in view the end required in her operations, but the most convenient method of arriving at it. Symmetry of form, the not taking up unnecessary room, facility of executing movements, all require that the parts concerned in motion should be as compact as

possible; and though there is necessarily a loss of mechanical power, in combining these advantages, yet nature has given to every muscle, power sufficient to execute what is required of it, independently of the loss which is thus sustained. If, instead of fixing the cord at two inches from the joint of the rule, we fix it at the extremity (C), it is clear that we shall act with greater power in bending the joint; but then, if we consider the cord as a muscle, there would have been a structure more like a large web, than a compact muscle, had nature aimed at employing the utmost extent of mechanical power in her muscular operations. This is obvious on shortening the cords (B D and C D) to such an extent, for example, as to double the joint (at A) in the way that you now see it; for, in this case, the whole space (A C D) between the two bones which the rule is intended to represent, will be filled by muscle, instead of merely a small part (A B D).

It would likewise happen, that if the muscle were inserted at, or near the extremity (C) of the rule, not only must the quantity of muscle be larger, to produce the same quantity of effect, but the muscular contraction must be much greater than if it were inserted (at B) nearer the centre of motion. Thus the length of the cord (B D) would be longer in the expanded rule than in the doubled one, by the length of the superfluous portion (D E); but then, if the insertion were at or near the extremity

(c), it is clear that the line (D F) which remains, after the same degree of contraction is produced as in the former case, would not only be much greater in itself, but would be much greater in proportion to the respective length of the muscles, than if the insertion had been at B. For instance, a contraction equal to D E, or about one fifth of the supposed original muscle (B D), will produce the same effect as a contraction equal to D F, or two thirds of the supposed original muscle (C D).

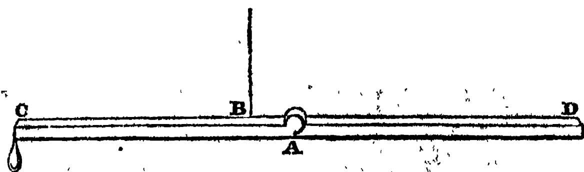


Nature, therefore, produces the same effect with a smaller portion of muscle, and a smaller portion

of muscular contraction, than would otherwise be necessary; though more power is required to compensate for the disadvantage under which it acts. But perhaps you will point out to us, Charles, the precise difference of power necessary when a muscle acts near, or at a distance from, the centre of motion.

CHARLES.

If the centre of motion is at A, the power at B, 2 inches from it, and the weight 5lbs. at C, at a distance of 12 inches from the centre of motion (taking the proportions of your rule as a diagram), then the power necessary at B, to raise the weight at C, is to the weight, as the distance (A C) of the weight from the fulcrum, is to the distance (A B) of the power from the fulcrum. The power at B must therefore be as the weight 5lbs. multiplied by the distance from the weight to the fulcrum, or 12 inches, which gives 60, to the weight multiplied by the distance from the power to the fulcrum, or 5lbs. by 2 inches, which gives 10; so that six times the power is necessary, when placed at B, to raise the weight at C, to what it would be if placed at C.

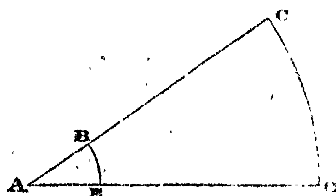


HARRIET.

Then, in fact, the power necessary is greater, the nearer it is to the centre of motion; and it would diminish, just in the proportion that the distance from the centre of motion increases.

CHARLES.

Certainly; and there is another mode of exemplifying the same thing. If, with the same letters, you suppose a power to act at B, then the same quantity of contraction which will bring B to E, will, in the same time, bring C to D: but the velocity must be as much greater as the distance A C is, compared with A B; or as the space passed through, C D, is to the smaller space B E. The space passed through, in a similar time, is therefore a measure of the velocity, and this of the power exercised to produce the effect.



SOPHIA.

It appears obvious, therefore, that it is the

object of nature to insure rapid movements, and to give an extraordinary degree of power for the purpose of effecting them, rather than to husband power, and take a longer time in producing the effect required.

DR. A.

This is, doubtless, the case; and there is no question, as Archdeacon Paley very properly observes, that, in what concerns the human body, it is of much more consequence to any man to be able to carry his hand to his head with due expedition, than it would be, to have the power of raising from the ground a heavier load, of two or three more hundred weight, for example, than he can lift at present. This last is a faculty which, on some extraordinary occasions, he may desire to possess; but the other is what he requires, and uses, every hour or minute.

CHARLES.

But is there not likewise a great loss of power in muscles, by their being inserted into bones at very small, and therefore unfavourable angles?

DR. A.

This is a circumstance which operates very strongly in every muscle, though much more so in some than others.

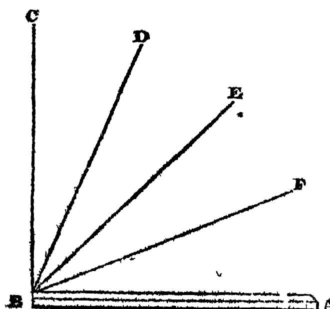
SOPHIA.

I wish, Charles, you would explain this point.

I am often puzzled in the application of reasoning about the magnitude of angles.

CHARLES.

If you wish to act with the greatest power, in raising or pulling any thing, you employ your force in a strait line from the object, that is at right angles to it; as in raising one end, B, of the bar A B, where the force exercised at B, in the direction B C, is evidently employed at a right angle. Now, if you alter the direction of the force employed, progressively, to D B, E B, and F B, you will find that the force required on your part is continually augmenting, just as the angles D B A, E B A, and F B A, are diminishing; and at last, if you act in a straight line from A to B, you will produce no elevation in the end B at all.



SOPHIA.

I now see clearly, that at a very small angle, there would be a great difficulty in accomplishing the object.

DR. A.

And, of course, there is a greater allotment of power, for the purpose of overcoming the difficulty. But in order to place before you, very distinctly, the great additional force which is thus required, I shall mention the calculations made by Haller, one of the most distinguished physiologists that ever existed, of the force required to be exerted by the deltoid muscle of the arm, in order to raise a weight of 60 pounds at the elbow, reckoning that the arm weighs 5 pounds of this.

CHARLES.

Is this muscle so called, from its resemblance to the Greek letter delta?

DR. A.

It rises above the shoulder, and is implanted at the fore part of the arm, at an angle of 10 degrees, at about one third of the distance between the shoulder and the elbow. As its origin is broad, and it is contracted at its insertion, it was thought to resemble the letter delta (Δ), though reversed. You have seen that the force required to raise a weight, by the previous explanation, was in the proportion of the distance which the weight from

the fulcrum, bears to that of the power from the fulcrum.

HARRIET.

Yes, when the weight was 5 lbs. and the proportions as 12 to 2, or 6 times, then the difference of power exercised was 6 times greater, or as 60 near the fulcrum; whereas it would have been only 10, had it been applied at the place of the weight.

DR. A.

Take therefore the insertion of the deltoid muscle at one third of the distance between the shoulder and the elbow, the force exercised there, is three times the amount of what it would be, if inserted at the elbow.

HARRIET.

Certainly.

DR. A.

Three times 60 are 180, and therefore it is clear that the actual weight, as far as the muscle is concerned, becomes 180 lbs.—But this is not all, the insertion of the muscle at an angle of 10, instead of 90 degrees, takes off the purchase in the proportion, as mathematicians have calculated, which 173 bear to 1000. The augmented weight, or, what is the same thing, the increase of power necessary to raise it, amounts therefore to no less than

1058 lbs. instead of the original 60 lbs.—The loss of power, however, does not end here; for the tendon of the muscle is never directly continuous with the fleshy fibres; and here then is a loss of power, in the proportion of the obliquity of the junction of these fibres to the tendon. This will be clear to you, when you consider, that if you wished to draw any thing to you, through the medium of a bar or stick, you would do so by means of a straight, not a crooked one. Hence, in the deltoid muscle, there would be a further loss of power of 228 lbs., which would augment the muscular energy required by it, to 1284 lbs.

SOPHIA.

What an immense exertion of force is thus demanded, and yet we are not at all sensible of any inconvenience from its exercise. Such power nature has bestowed on this part of our frame.

DR. A.

But, besides all the points which I have mentioned, there is another circumstance which we are to take into account, in considering the action of muscles; and this is, that action and re-action, in mechanics, are equal, and therefore that as much power is expended in resisting the bone, which affords a fixed point at one end, as there is in elevating the weight at the other; and hence the

last amount of the calculation, or 1284 lbs. is to be doubled, or made 2568, in order to come to a correct view of the force exercised by the deltoid muscles in raising 60 lbs. at the elbow.

SOPHIA.

I hope you have now got to an end, for the power of the deltoid, like the prowess of Sir John Falstaff, seems to go on increasing at every step.

DR. A.

But physiology beats him; for his two men in buckram increased but to eleven; while our original 60 lbs. have grown up to 2568 lbs. — In the animal body, there are various muscles which combine their actions for some particular purposes; but then a certain degree of the force of each is lost, because the operation is rendered less direct.— It likewise frequently happens, that particular muscles have their fibres disposed obliquely; and this will readily appear to you, from what I have already said, to be a saving of extent of contraction, by a larger expenditure of power. When nature had an important object to accomplish, loss of power does not appear to have been at all regarded in the construction of our frame; but at the same time, no opportunity was lost, to augment the mechanical power of muscles, when this could be done without inconvenience. The increased magnitude of the heads of bones; the

projecting processes of various bones, particularly those of the thigh and heel; the bones placed as appendages to some others, as the patella, or knee-pan, and the sesamoid bones, which are placed at the fingers and thumb; all of them afford opportunities for an increase of the angle under which muscles act, and therefore for an augmentation of their powers.* To this I may add, as conducive to the same object, the smoothness of the cartilaginous surface of the joints, and the careful provision of a plentiful supply of synovia to lubricate them.

CHARLES.

Muscular contraction seems to be a thing which cannot be imitated; for while, in mechanical processes, cords or chains, when shortened, must be coiled up, or otherwise disposed of, a muscle simply contracts itself, and thus produces the necessary approximation of two parts together: but, considering the immense variety of motions which the different parts of our bodies are intended to perform, the number of muscles must be exceedingly great. Has this been ascertained with any correctness?

DR. A.

There are more than 500 muscles in the human body, all which are continually subservient to the purposes of motion, and are ready to carry into effect our will, in whatever way we may wish to

exercise it. It would be foreign to my object to give you any account of the names, origin, and uses of the muscles generally, which is a subject requiring much study and attention; but it will be satisfactory for you to be told of the number and distribution of those which are necessary for performing the motions, for example, of the arm and fingers; and they will give you an idea of the immense provision which the animal frame possesses in this part of its economy.

There are seven muscles which are principally employed in raising the arm at the shoulder joint, in different directions, and with different degrees of obliquity; and five in depressing it, of which two, which are of great strength, are felt at the armpit, from their being inserted at some distance from the head of the bone, in order to increase their power, particularly when a severe blow is to be given, as by a hammer. These muscles form the flesh round the shoulder joint, part of that on the side, back, and breast, and the greater portion of what covers the shoulder blade.

The fore-arm is moved by four muscles, which form the mass of flesh between the shoulder and the elbow, and, being planted below the elbow joint, are employed in bending and extending it.

The mass of flesh covering the fore-arm consists of muscles, which are employed in turning the palm up or down, in bending and extending the

wrist, and in bending and extending the fingers and thumb. There are not less than 17 of these; and on the hand there are as many more, which form, principally, the fleshy part of the palm. So that for the purpose of effecting all the motions of the arm, hand, and fingers, the action of near 50 muscles is necessary; all of which are regular in their origin, course, and insertion; have all separate names, derived principally from their use; and are all capable of being pointed out by the anatomist.

HARRIET.

In what way are the different muscles kept distinct from each other, so as to be enabled to act separately, and without interference? One would suppose, that, from their great number, there would be some danger of this.

DR. A.

Muscles form bundles of flesh, of greater or smaller magnitude, separated from each other by cellular membrane, which allows them to move freely over each other.

HARRIET.

The cellular membrane seems to be a substance of very great importance; it is found every where.

DR. A.

I have already mentioned its general nature to you, in noticing the structure of the bones; but

two or three other particulars I may now point out. Its universal diffusion I have stated; for it is found, as well among the firmest muscles, as the finest membranes of the body, as, for example, those of the eye. To the communication of its cells, it is owing, that pitting is produced where water has been secreted into them, as is the case in a particular description of dropsy. This arises from the fluid being forced by the finger into contiguous cells, from which, however, it soon returns, and fills up the indentation, or pit.

SOPHIA.

Then, I dare say, it is owing to the descent of the water, by its weight, that the legs of dropsical people swell, when they have been up some time, and fall on their assuming the recumbent posture.

DR. A.

You are quite right; and the use of a laced stocking, or a bandage, will, by giving support, prevent, to a certain degree, this effect from occurring.

CHARLES.

There would be this disadvantage, I should think, attaching to the general communication of the cells, that, in case of matter forming in any particular part, it would spread far beyond the place of its deposition.

DR. A.

This would, unquestionably, happen, except for a wise provision of nature, by which the same disorder which produces the collection of matter, namely, inflammation, occasions an adhesion, or sealing up of the cells around the collection or abscess, which circumscribes disease, and obviates the occurrence which you suggest.

CHARLES.

Is this adhesive effect of inflammation a general one, or is it merely adopted in this particular instance, for the purpose of preventing the diffusion of matter?

DR. A.

It is a general one, and, in fact, forms the principal means which nature employs to repair injuries; as is exemplified by the slightest cut. The part first bleeds; and after the vessels have contracted, so as to resist any further loss of blood, they throw out a lymph, which acts as a sort of glue, and binds the parts together. A certain degree of inflammation is always necessary for this operation, as you may know by the tenderness which occurs at the edge of a little wound, such as I now mention.

SOPHIA.

I have often observed this, and have sometimes interrupted the progress of healing, by accidentally

separating the edges which were half glued together.

DR. A.

Inflammation is one of the most frequent, and important diseases in the human body; and yet nature has employed it in effecting many salutary operations. So ingenious, and so simple are her arrangements.

The cellular membrane is the substance into which fat is thrown, whether under the skin or in other parts of the body; and it has been supposed by some physiologists, that there is a particular set of cells destined to receive this secretion, in as much as it does not escape, like water, when an opening is made in any particular cell; nor does it pit, on pressure, as when there is a watery deposit. — But to return to the muscles. When any particular motion is performed, you may generally feel the muscle producing it, as a hard sort of band, amid a mass of soft flesh. This you may readily do, in the inside of the arm, when you bend, and in the outside of the arm, when you extend the fingers.

CHARLES.

The contraction may be both felt and seen; and as I suppose the same is the case in other parts of the body, I should think that it would be exceedingly useful to the painter and sculpter, to

have a correct knowledge of the muscles, in order to depict their action with sufficient accuracy.

DR. A.

Unquestionably; and hence the Royal Academy has a professor of anatomy, whose duty it is to teach so much of anatomy to the students, as is necessary for the practice of their art. The particular kind and degree of action is likewise pointed out, as well by drawings, as by the movements of muscular persons, who are directed to take particular attitudes, and make particular exertions.

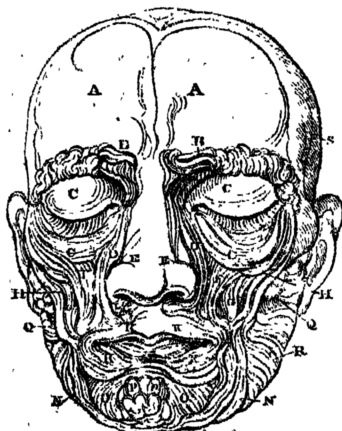
HARRIET.

The various emotions of the mind produce a powerful influence upon the countenance; and this is, I suppose, through the medium of the different muscles of the face, whose peculiar positions and actions, I should imagine, it would be important for the artist to study.

DR. A.

Certainly; and as you and your sister are both something of artists, I shall show you, from Mr. Charles Bell's pleasing work on the Anatomy of Expression in Painting, a sketch of the muscles of the face, with his description of their names and modes of action, by which you will be able to see what varieties of expression they are capable of producing.

In this drawing, the integuments are supposed to



be removed, and the muscles separated from each other below it.

HARRIET.

What a great number there is of these muscles, and how variously they seem to be entangled with each other. Have these muscles particular designations?

DR. A.

They have, as I shall immediately point out to you by a reference to the letters affixed to the sketch.

The uppermost muscle, A A, is the frontal; which is, in fact, part of a larger one, called the occipito-frontal, that has a portion on the back of the head, and another, the frontal, on the fore-

head: B B, is the knitter of the eyebrow (corrugator supercilii); and C C, the circular muscle of the eyelids (orbicularis palpebrarum).

The action of the fore and back part of the occipito-frontal muscle, is that by which some people are able to move the scalp to a great extent, and even to throw off the hat. The contraction of the eyebrows is principally effected by the action of the corrugator supercilii; and the shutting of the upper eyelid (for the lower one does not take a part in this case) is by the action of the circular muscle. In some complaints, and in drunkenness, the eyebrows are unequally elevated; and Hogarth has made an admirable use of this circumstance in many of his pieces, in depicting the countenance of a drunken man.

D, is termed the elevator of the upper lip and nostril;

E, the compressor of the nostril (compressor naris);

F, the elevator of the upper lip;

G, the elevator of the angle of the mouth;

H, the zygomatic muscle, which assists the last.

These muscles, with the exception of the compressor of the nose, raise the mouth, make the cheek full, and give an air of cheerfulness.

K is the circular muscle of the lips;

L, the depressor of the nostril;

M, the nasal muscle of the upper lip;

N, the triangular, or depressor of the angle of the mouth;

O, the depressor of the lower lip;

P, the elevator of the chin.

Expression of countenance, it may be observed, depends very much on the eyebrows, and angles of the mouth, and on the various motions made in these parts, by the muscles which I have just mentioned.

Q is the buccinator, or blower. It draws the angle of the mouth directly backwards, and contracts the cheeks when they are distended with air.

R is a thin web of muscular fibres, called platysma myoides, or broad muscle, which covers the side of the neck, and expands over the face. The part which passes forward to the angle of the mouth has been called risorius, or the muscle of laughter.

S is the last on the plate, and is termed the temporal muscle.

CHARLES.

The varied action of these muscles produces, then, I suppose, all the variety of expression of which the human countenance is capable; and in proportion as one set of passions, or another predominate in the human character, something of a permanence of appearance may be communicated. This, I should imagine, must be the only proper foundation of physiognomy.

DR. A.

So I should think; but Lavater, the celebrated physiognomist, in devising his system (if it can be called such), seems to view the different features, as possessing an original character from nature, which it only requires attentive observation to discover.

As you, Harriet, have made some advancement in the drawing of figures, you will find an advantage in studying, with your mother, some of the masterly delineations of the passions which are given in Mr. Bell's work; but it may be advantageous and interesting to all of you, that I should now point out, by a reference to the sketch, some of the characteristics of the principal passions.

Rage is distinguished by unsteadiness of features; by the rolling and glaring eye; by the action of the muscles of the forehead, which alternately knits them, and raises them in furrows; the inflation of the nostrils; the swelling and expansion of the lips; and, in fact, by a violent and irregular action of almost all the muscles of the face.

HARRIET.

In brutes it seems to be principally the glare of the eyes, and the exposure of the teeth, which give the appearance of ferocity which they exhibit in this passion.

DR. A.

This is the case very much with animals of the

dog and cat kind; and the exposure of the teeth depends on the action of the muscles, called snarling muscles, which go from the margin of the orbit of the eye, and are inserted into the upper lip: but the lips have no regular circular muscle for contracting them, as in man; and they therefore hang loose, and relaxed, unless when they are contracted by the snarling muscles. Some of the more ferocious of the carnivorous tribe, as the lion and tiger, owe the peculiar glare and fierceness of the eye, Mr. Bell tells us, to the contraction of three muscles which are peculiar to them, and which, being fixed in the eyelids, draw them back on the prominent eyeball, and these produce the fixed straining of the eye; while, by stretching the coats, they give a greater brilliancy to the reflection from them. We shall afterwards find, when on the subject of the eye, that there is a peculiarity in the organ, which is another cause of the glare which the eye possesses in animals of the cat kind.—Graminivorous animals do not exhibit rage in this ferocious way; but principally by effects on the general system. Their eyes glisten, their nostrils swell, and they prepare their bodies for offence; but they are without the power of raising the lips, as in snarling, though they can do so, in such a way as to be allowed to feed; but for this particular action, they are provided with a

muscle which is at the front, instead of the sides of the mouth.

CHARLES.

Man seems to possess some of the attributes of the carnivorous race, in his indications of rage; for the lips are forcibly drawn upwards, in a manner somewhat similar to that of the more ferocious animals: but I suppose that, in them, the nature of their covering prevents the other indications of rage from exhibiting themselves, which are so marked in the human countenance, when acted on by this passion.

DR. A.

This must be in some measure the case; but it is likewise to be observed, that in man, there is a union of all the capacities for expression which belong to quadrupeds; and also several peculiar muscles, which seem to act as organs of expression, and to be capable of indicating emotions and sympathies, of which the lower animals are not susceptible. The knitter of the eyebrow is one of those peculiar muscles; and in its contraction, during rage, there is a mingling of mind and sentiment, with mere animal feeling, which distinguishes, in some degree, the ferocity of a man, from that of a brute.

SOPHIA.

I suppose, then, that if a dog's face, or that of any other animal, were dissected, like the human, of which you have shown us a sketch, the muscles would be found much less numerous.

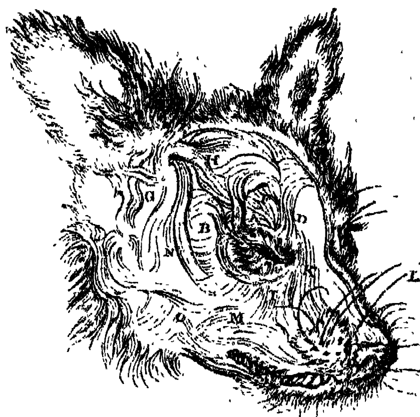
DR. A.

Certainly; and the difference is very well exemplified by a drawing which Mr. Bell gives of the muscles of a dog's face, of which I now show you a sketch; and you will see, on comparing it with the sketch of the muscles of the human face, what a paucity there is in the former, compared to the latter; and what little variety of feature the one is capable of exhibiting, to the other, if even there were not the covering which Charles supposed likely to prevent small contractions of muscles from being discernible.

In this sketch, A A are the circular fibres, which surround the eyelids, and are common to all animals.

B C D are accessory muscles, called by Mr. Bell scintillantes, or glistening, which draw back the eyelids upon the eyeball, and give a sparkling fierceness to the eye.

F G H are muscles of the ear, which, in many animals, are well adapted to vary its direction, and



give it the necessary tension, to receive the vibrations of sound.

I K form, with the layer of muscles immediately below, the snarling muscles, as Mr. Bell terms them, whose action raises up that part of the upper lip from which the whiskers grow, and which is opposite to the canine teeth, and produces the peculiar, and well-known expression of displeasure in the carnivorous animal.

L is the muscle moving the nostril in smelling.

M, the muscular fibres of the mouth, which do not, as in man, make a perfect orbicular muscle; and the lips, therefore, unless when acted upon by the snarling muscles, hang loose and relaxed.

N, a muscle which retracts the angle of the mouth, and is useful in mastication.

O, a cutaneous muscle, which sends up fibres from the neck to the side of the face.

In the horse, it may be observed, there are muscles which raise the upper lip, and draw down the lower, at their middle, so as to uncover and protrude the fore teeth in feeding or biting. This animal has also muscles which draw the eye backwards, so as to increase his field of vision in that direction. The other graminivorous animals have a similar disposition of muscles in the lips.

Having given you this general description of the muscles of a dog's face, to enable you to compare them with those of the human countenance, I shall go on with the sketch which I was giving you of the peculiar designations of the passions.

The character of *suspicion* is a rigid contraction of the eyebrows and muscles of the face, as if under extreme attention; and a timorous side look of the eyes. *Discontent* is remarkable for the contracted forehead, the arched nose, and the depressed angle of the mouth. This last is dependent on muscles which are peculiar to man, and are called the triangular, or the depressors of the angles of the mouth; which give a very peculiar expression to the features, such as is not discovered in any other animal, in contempt, hatred, pride, and jealousy.

The effects of *fear* are to relax the energies of mind and body: the eyebrows are elevated, the eyes largely uncovered and staring, the mouth opened, and the breath spasmodically affected. There is a trembling in the cheek, lips, and muscles at the side of the neck; the countenance is pale, from the receding of the blood, and the hair rises, from the contraction of the skin.

CHARLES.

It appears that the effects of ordinary fear and rage are as nearly as possible opposed to each other, not only in their nature, but their physical effects; for while the latter excites, the former depresses every energy to the utmost extent. The elevation of the eyebrows, instead of their contraction, must produce a remarkable difference between the expression of the one and of the other.

DR. A.

In *smiling* and *laughing*, the circular muscle of the lips is relaxed; but in laughing, there is conjoined, an action of the elevating muscles of the cheek, which draw the angles of the mouth upwards and backwards, and accumulate, as Mr. Bell terms it, the cheek upon the eye; the mouth is open, the eyes half closed; the nostrils are dilated; and in a hearty laugh, the eyes are suffused with tears. There is, at the same time, a convulsive state of the respiratory organs, which, every

one knows, is sometimes to an inconvenie uncomfortable extent.

SOPHIA.

But how does it happen that we cannot shedding tears in a hearty laugh?

DR. A.

Because the action of the muscle of the raises the cheek against the eye, while the c muscle of the eyelid is brought into action, and presses on the eyeball and on the little gland, called the lachrymal gland, which I shall afterwards have occasion to mention to you, as secreting the tears.

Conjoined with the action of the circular muscle of the eyelid, is that of the occipito-frontal, which unites with the former in giving an acute arch to the eyebrow. — The action of the depressors of the angles of the mouth converts a smile, or a laugh, into a sneer. — In *crying*, there is a sort of convulsive action in the muscles about the eyes. The cheek is raised, the nostril drawn up, the mouth stretched laterally, and its corners rather depressed, while the eyebrows are drawn down. There is likewise a convulsive action in the organs of respiration, which is very peculiar.

CHARLES.

The production of tears does not, I suppose,

arise from the same cause in crying and laughing; namely, from pressure on the lachrymal gland.

DR. A.

The shedding of tears in weeping, is always preceded by a pungent sensation in the membrane of the nose, which seems to excite a sympathy, not very well understood, on the lachrymal gland; and hence we find, that though the features may be commanded, the tears, under certain circumstances, will not be controlled. We must, however, defer the prosecution of this subject till our next meeting.

CONVERSATION VI.

THE MUSCLES CONTINUED.

SOPHIA.

You mentioned, at our last meeting, that there are some particular organs of expression peculiar to man, and to which there is nothing of resemblance in brutes. Is there any thing like laughing or crying among any other but the human race?

DR. A.

These indications of joy and grief are wanting in animals, for they have not the muscles on which they depend. They will testify joy and sorrow by some demonstrations of their own; but they are without the means of producing that variety and change of features, on which so much of the dignity of the human countenance depends. The orbicular muscle of the lips, and the muscles which are placed about the angle of the mouth, give a power of minute expression of feeling which is quite peculiar to mankind.

HARRIET.

But if there is not laughing, there seems at least to be crying among some of the brute creation;

for Thomson, in his description of the stag standing at bay, tells us, that

> The big round tears run down his dappled face.

DR. A.

The same is also mentioned as occurring in some other animals. For example, the phoca ursina, sea bear, or ursine seal, has been said to shed tears copiously, when wounded, or when its young have been taken from it. Pallas states, that when the Mongols find that the camel will not suckle its young, (which is very rarely the case) they excite the maternal feelings, and elicit copious tears from the old one, by employing a plaintive melody, imitating the voice of the young animal. Humboldt informs us, that a small American monkey is melted into tears on any fright or disquiet; and the keeper of the orang outang, brought from Batavia by Dr. Abel, assured Mr. Lawrence, as the latter gentleman tells us, that he had seen him weep a few times.— In all these instances (if quite correct), there is certainly more of the appearance of human sorrow, than usually occurs out of the pale of mankind; but yet it is to be observed, that all quadrupeds secrete tears, and may therefore have the flow of them increased under particular circumstances. The flow of tears, however, is, as you may recollect, only a part of the indication of sorrow; for it is the alteration of features which represents emo-

tion; and, this, with very little exception, and that applying principally to rage among a certain tribe of animals, as I have already mentioned, is entirely confined to the human race.

"This capacity of expression," says Mr. Bell, "this indication of a mind susceptible of great, or of tender emotions, has a great share in human beauty; whether in the living countenance, or in that which the pencil presents. How different the tame regularity of a merely placid countenance, from what strikes the spectator when he beholds the indications of a great mind in that susceptibility of emotion and energy, which marks the brow, and animates the eye of the hero, even in the calmest scenes of life! How fascinating, when compared with the insipid prettiness and regular features of an inanimate beauty, is that susceptibility, which lightens up the countenance, and plays upon the features of a woman of sensibility, even while she is unmoved by any particular affection!

"It is this emanation of the mind inspiring the features, and giving grace to the action, which produces the enchanting effect in painting. And if there be such a thing as pleasure arising from mere form, without expression and character, which I much doubt, it is a pleasure which must be very transient. In every possible condition and state of existence, there is a certain character to be

given to the body. It is alive, or dead; still, or in motion; it has the spirit and buoyant spring of youth, the massiness of manly strength, the grace and elegance of female beauty, or the cautious timidity and constrained motions and postures of old age, legibly impressed on the whole figure, and prescribing every motion and position of the body."

HARRIET.

The study of expression, as varied by the different emotions of the mind, seems, from the interesting details which you have given us on the subject, to be totally different from that of physiognomy; but I should be very curious to know on what leading circumstances Lavater depends, in forming his conclusions as to human character and capacity.

DR. A.

His work seems to be a series of observations hardly referable to any precise principle. He considers the bones of the head and face as the ultimate foundation of it, and as both giving to, and receiving from, the soft parts which are attached to them, a sort of permanent character and influence. He mentions, in great detail, and with numerous examples, the different appearances produced by various modifications of forehead, eyebrows, eyes, nose, lips, and chin; and recommends the study of silhouettes, or the profiles of countenances,

as giving every information which is necessary to the study of character, in a way superior even to the best portraits. He considers plaster models as much better than the countenance itself, for communicating an insight into the mind and disposition, because they can be viewed and studied in various ways, and measured and silhouetted in every direction; and he distinguishes, in silhouettes, nine horizontal sections, which I shall mention to you, as forming so many series of parts, to which the attention is to be given, in order to judge of character.

The first is the curve from the top of the head to the commencement of the hair at the forehead.

The second is the contour of the forehead to the eyebrow.

The third is the interval between the eyebrow and the root of the nose.

The fourth is the nose, to the commencement of the lip.

The fifth is the upper lip.

The sixth is the two lips taken together.

The seventh and eighth are the height and depression of the chin.

And the ninth is the neck, in which he includes the back of the head.

Every one of these parts, he enthusiastically tells us, "is a letter, a syllable, a word — often a decisive judgment, an entire discourse, on ever

truth speaking nature;" and he views, in his favourite object of contemplation, the profile, a positive and incontestable proof of the reality of the science of physiognomy, and one which, when the sections are in perfect harmony, affords such a decided insight into character, as to be distinctly read by a peasant, or a child.

After having given you so long an account of the effects of muscular action in communicating expression to the features, it is necessary to resume the examination of the general operation of muscles: and here I would observe, that a consideration of the motion to be performed, will generally show in what direction the muscles must lie, in order to perform it. Thus it is clear, that the muscles which bend, must lie in the fore part of the arm, and those which extend, on its back part; just as you may see that the rule, with which I have exemplified muscular action, must have its cord, which is to double it up, on the inside, and that which is to return it, or what is similar in effect, to extend it, on the outside.

SOPHIA.

One sees occasionally people with various workings in their face or limbs; are these from an action of muscles, which they are unable to prevent?

DR. A.

Certainly; muscles are subject to what are

called spasmodic affections, during which they contract, and perform certain actions independently of the will. Sometimes, too, only a few fibres of a muscle are affected; and then a sort of twitching is produced, which consists of alternate contractions and relaxations, and is rather uncomfortable.

HARRIET.

Cramps, I suppose, are of the same description, —violent contractions of the muscles.

DR. A.

They are so; but here the relaxation or cessation of action does not take place; and the continuance of the violent action becomes exceedingly painful.

HARRIET.

But I have seen persons where there has been a distortion of the countenance, as if from a permanent contraction; and yet there did not seem to be any cramp.

DR. A.

There was, in this case, a loss of power of the muscles of the opposite side, from palsy, most likely, by means of which the sound muscles, from there being no natural power on the opposite side to act against them, take a more contracted position than usual.

CHARLES.

Then it appears, that when the mouth is seen

drawn to one side, it is not the side in which the distortion is most manifest, which is the part affected, but the opposite one.

DR. A.

This is precisely the case; for all the actions which we perform, by means of certain muscles, over one side of the mouth, we can also perform, by means of corresponding muscles, on the other side of the mouth; and when neither sets of muscles are in action, they balance each other, so as to keep the mouth even. In the case of paralysis of the muscles of one side, the power of these muscles is lost, and the balance is destroyed. The same happens in various other parts of the body, as in the tongue and neck, where the muscles are disposed in pairs, and are said to be antagonists to each other. I may also remark, that whenever there is a muscle which moves a part in one direction, there is another muscle, or set of muscles, to restore it to its former state. For instance, if you bend the arm, you act with the flexor muscles to produce this effect; but, in order to bring it to its usual state, you act with the extensors, and gradually withdraw the action which bent the arm. A mere cessation of contractile power would leave the limb, where it was, to obey the mere operation of gravity upon it; but by this reciprocal operation, muscles act, as Dr. Paley very aptly states it,

like sawyers in a pit, by pulling at different times, in opposite directions.

SOPHIA.

But considering the great number of muscles which there every where is, there seems to be hardly space sufficient on the bones for their insertion; and near the joints, the muscle seems to cease.

DR. A.

Nature has adopted a very ingenious plan for diminishing the space necessary for the insertion of muscles, and this is, by the use of what I have already mentioned to you, as tendons, or sinews. These are a species of ropes, which occupy little space in their attachment to the bone, and therefore allow a free motion of the joint, and a greater symmetry than if the joints were covered with large masses of flesh. They are very strong, and are firmly attached to the muscles, which, at a certain distance from the joint, expand into a fleshy mass, so as to fill up the surface between one joint and another.

CHARLES.

Then I suppose the tendons are merely muscles more consolidated, so as to occupy less room.

DR. A.

Their nature is very different, tendons being principally composed of gelatine, while muscles

consist chiefly of fibrine, or the fibrous part of the blood, which I shall afterwards have occasion more particularly to notice. They have no power of contraction, and are therefore merely passive, following the impulse which the muscles give them, to which they are firmly attached, and capable of being separated from them by maceration, or boiling. Sometimes the tendons are of great length, as in the fingers; and you may observe that the back of the hand is covered with thin cords or tendons, which belong to the muscles that extend the fingers, and which lie on the outside of the arm. It is evident that in this case, the hand and fingers would have been much incommoded in their various and delicate motions, by a larger mass.— Every muscle is bound round or encircled by a membrane of cellular substance, called a sheath, which serves to give it additional protection, and also to preserve the muscles in their place; for the cellular membrane, as I have before observed, having a loose kind of union throughout, preserves the parts in their relative position, without at all impeding their motion upon each other.

CHARLES.

But as the muscles and tendons are in such continual motion over each other, is there any inconvenience from this friction, or any means employed to prevent it?

DR. A.

The muscles being of a soft nature, can move over each other glibly, and without difficulty; but it would be different with the hard cords which form the tendons; and therefore nature has wisely formed, whenever there is friction of tendons upon tendons, muscles, or bones, a small cavity, called a bursa mucosa, or mucous bag, of cellular membrane, which has a secretion poured into it, resembling the glairy liquor, or synovia of the joints, that facilitates motion, and prevents injury from friction or pressure.

HARRIET.

You mentioned that muscles have both an origin and insertion in bones; but how is it with the tongue, whose motions are so numerous, and where there is no bone to which its muscles can be attached?

DR. A.

I particularly spoke of motions where joints are concerned; but there are various other motions, to which muscles are subservient, in which the plan adopted in the limbs is not admissible. In the instance of the tongue, there is a bony attachment of muscle, only at the back part; while towards the point of the tongue, the muscles are curiously united to each other, so as to admit of every description of motion with the utmost facility. This

structure is necessary in the production of all the minute differences of action requisite to the formation of language; and in order still more to facilitate the movements of this active little organ, it is attached, behind, to a bone called the os hyoides, from its resemblance to the Greek letter υ, which is so fixed to the neighbouring parts as to admit of some degree of motion. This, it is obvious, must be of particular importance in the act of swallowing, when any unyielding body would be very much in the way. — But some muscles, it must be observed, are not attached to bones at all; for instance, the heart, which we shall find is one of the most powerful muscles of the body. The stomach and bowels, likewise, have a muscular structure, which is connected with the propulsion of the food.

HARRIET.

But I thought that muscles always obeyed the will; the motion of the heart, and other internal parts, is quite independent of any power of guidance.

DR. A.

Certainly; but all muscles are not obedient to the will; and hence they are divided into voluntary and involuntary muscles. For as there are certain functions, as those of motion, which must always be performed with consciousness, there are others

which must continually go on, and which nature has therefore wisely ordained to be quite independent of any thought or arrangement of our own. As examples of this, I may mention the action of the heart, in projecting the blood; and that of the stomach and bowels, in passing on the food which has been received into them.

HARRIET.

This is admirably managed; for I fear that if we had the guidance of all the functions of our bodies, we should be very apt, in our anxiety that some processes should go on well, to overlook others, and thus act much like a husbandman, who might have the winds and weather at his disposal. But this exertion of voluntary power over a muscle seems to be very surprising: we have only to will a particular action, and the action follows the thought.

DR. A.

This is really the case, and a most surprising phenomenon it is; for there is no perceptible interval between the willing to do a thing, and the completion. Our muscles, therefore, seem to be a set of obedient servants, placed in every part of our bodies to do our pleasure.

CHARLES.

But what sort of influence is that which is thus

exercised by us, and how is the power communicated?

DR. A.

These are questions which can be but very imperfectly answered, for they involve that inscrutable connection between the material and immaterial part of the animal body, which we know only by its effects. We are conscious of the exercise of will, and we see that action follows this exertion; but most of the intermediate steps are beyond human cognizance. Placed at a distance from all the muscles, the brain communicates an influence to them through the medium of the nerves, either directly, or by the intervention of the spinal marrow. If the connection between the brain and a muscle is cut off, as by an accidental division; or the energy of the nerve lessened, as in palsy, then the muscle has not the power to obey the will, or does so very imperfectly. Hence the nerves are the media by which the will acts upon the muscles: but how the nerves are acted upon by the immaterial, and consequently the nobler part of the animal constitution, is one of those arcana which the divine Creator has not permitted to be known to us.

The celerity of muscular action is very astonishing. It has been calculated that 1500 letters may, by very rapid communication, be pronounced in a

single minute; and if you consider, for an instant, the astonishingly rapid movements which the fingers are capable of making in writing, or in musical execution, you will be able to imagine, in how minute a portion of time muscular actions are performed.

SOPHIA.

Habit, however, I suppose, imparts a great facility in the exercise of such muscles; for it is very difficult to get the rapidity of movement which many performers on different instruments possess.

DR. A.

Movements have, in time, a certain association one with another, and this makes them appear to be in some measure independent of continued voluntary agency; but still the motions cease, as soon as the will to move is discontinued, and begin again when that is renewed. — The precision with which we can direct the motions of our limbs is extraordinary. We require no calculations, as the mechanist does, as to the power which we are to produce; for we at once do what we wish to do, and no more. This has been put in so striking a light by the late Dr. Barclay of Edinburgh, that I shall read you a passage on the subject, from his very excellent work on Muscular Motions. "Let us suppose," says he, "the circumference in which a bone can be moved to be 24 inches; that each

of the inches is equally divided into 12 parts; and that the bone may be assisted at each of the divisions, which we know to be possible; with what accuracy must the muscles contract towards the centres, in order to regulate their extent of motion with so much precision towards the circumference. In producing the several musical notes, by changes in the small aperture of the glottis," (which, by the by, is the opening from the mouth into the windpipe.) "or in balancing the body on the tight or slack ropes, we know that the muscles must contract with such minuteness and accuracy, as frequently to regulate their extent of decurtation, by smaller measurements than the 200,000th part of an inch."

SOPHIA.

This is very wonderful, and yet how little are the powers with which we are gifted, the daily operations of living beings, the subjects of remark, much less of the admiration which they are so well calculated to inspire.

DR. A.

The force which muscles are capable of exercising is very great. Three hundred pounds have been elevated by the muscles of the lower jaw; and when a person with a burden on his back, stands on tiptoe on one foot, the whole weight of the burden, and of the body, is borne by the extensor mus-

cles of the foot. — During action, the muscle itself seems to acquire a great addition of strength, and of power to resist injury; for a blow which would bruise the flesh very much, or break a bone, if received unexpectedly, and in a state of relaxation, can be received with impunity by muscles in a state of contraction. It is in this way that the feat of breaking a poker over the arm is explained; for the rigidity of the biceps muscle, which, as I have mentioned to you, lies immediately above the elbow, on the front of the arm, will, particularly if the power is increased by habit, receive, and repel, without injury, a very severe blow. — It is on the same principle, that Leather-Coat Jack, as he was called, who lived in the time of Dr. Hunter, was enabled to bear a carriage to pass over him, which he would do at any time for a very small recompense. After death, he was found to have very strong muscles, and large projections of bone, into which they were inserted, which gave him the faculty of very powerfully contracting his muscles, so as to resist the immense pressure which I have mentioned.

SOPHIA.

It seems to be upon the same principle that we can bear an impulse of any kind when we prepare for it, better than when it comes unawares.

DR. A.

Certainly. We oppose the contraction of muscles

against the impulse directed against us, and thus prevent the loss of equilibrium which would otherwise be inevitable.

HARRIET.

I have heard of experiments being made on the bodies of dead animals, by which movements were executed after death. How is this reconcilable with the doctrine of voluntary power, and of muscles being obedient to the will?

DR. A.

The muscles, during the state of life, have that kind of connection with the brain, by which, on the one hand, they are obedient to the will, and, on the other, communicate to the mind impressions made upon them. A certain structure, known by the name of muscular, is imparted to them for this purpose; and it is a property of this structure, on whatever circumstances it may ultimately depend, to contract when a stimulus is applied to it. If a portion of the scarf-skin were abraded, and the tender part touched by a pointed instrument, pain would necessarily be produced, but no muscular contraction. If, however, on the other hand, the abraded part were a muscle, you would see a contraction of the muscular fibres take place, or a species of convulsion. Now the same cause which produces this tendency during life, exists for some time afterwards; and is capable of being manifested,

more particularly by that modification of electricity, which is known by the name of Galvanism. — If, for example, in a dead frog, one extremity, with the skin taken off it, be placed on a piece of silver, and the other on a piece of zinc, and the two metals be brought into contact, convulsions are produced. The same happens, also, in any of the larger animals, when the Voltaic apparatus (in which the electric power is elicited, through the means of alternate pieces of zinc and copper, with a dilute acid interposed,) is made to complete a circle through any particular part of the body: at the instant of contact, convulsions are produced.

SOPHIA.

These must be very uncomfortable experiments. One shudders at the idea of involuntary motions; and cannot help fancying, that a portion of life and feeling must exist, when motion, the constant or usual accompaniment of life, is produced, under whatever circumstances it may occur.

DR. A.

The discovery of this particular mode of exciting muscular action, I must observe to you, though attributed to M. Galvani, was really due to his wife, who accidentally observed it when some frogs were lying on a table, ready prepared for making the soup which is so much used as a restorative in Italy, near an electric machine. While the ma-

chine was in action, one of the attendants happened to touch, with a scalpel, the crural nerve of one of the frogs, which was not far from the prime conductor, when it was remarked that the muscles of the limbs were thrown into strong convulsions. This experiment was performed in the absence of the Professor, but it was reported to him by his lady, who was much struck with it. M. Galvani repeated the experiment, varied it in different ways, and being engaged in a set of experiments, the object of which was to prove that muscular motion depends on electricity, he was induced, by this accidental discovery, to prosecute his inquiries with redoubled diligence.

The size of muscles, and the power which they possess, are very much connected with the quantity of their employment. The muscles of the legs in dancers; of the arms in blacksmiths; of the shoulders and back in porters; all of them obtain an increase of bulk, which still more fits them for the duties which they have to perform. In the lower animals, also, this is strongly exemplified; and whether they are principally accustomed to running, flying, or swimming, the muscles which are respectively used in these processes, acquire additional force and magnitude. In birds, there is a striking difference between the size of the breast-bone, and of the muscles implanted into it, in such as principally or occasionally support themselves on the

wing; and those, as the ostrich, or penguin, which employ the wings only as an aid to the feet. The muscular power of the wings may readily be conceived from the long flights which birds are capable of taking, and the short time in which they are performed. It is said that a pigeon will fly thirty miles in nine or ten minutes.

HARRIET.

Have people ever succeeded in adapting wings to their bodies, so as to support them at all in the air?

DR. A.

From the time of Icarus downwards, there have been many attempts; but they are quite absurd. All that can possibly be done is to imitate a sort of parachute, so as to diminish the celerity and force of a descent; for birds fly, as well by the size of their wings, as by the immense power of the muscles which move them, to which we have nothing in any degree similar. — Birds have likewise hollow bones, to make them more buoyant; and some of them (as we shall afterwards find) even pouches, which receive air from the lungs, in order still better to enable them to remain suspended in the air, or to float on the surface of water. The muscles of the breast of a bird are equal in weight to that of all the other muscles of the body put together; and it is clear, therefore, that, setting aside the other cir-

cumstances to increase buoyancy in which he is deficient, until man had a muscle of equal power, instead of the thin pectoral muscles which cover the side of his chest, and are inserted into his arm, he must be satisfied with something short of aërial flights. — The buoyancy which birds are capable of obtaining, through the means of hollow bones and air-bags, is strikingly evinced in the facility with which the majestic condor, the enormous vulture of the Andes, which is said to measure 14 feet with the wings extended, can suddenly dart, as Humboldt has seen him do, from the bottom of the deepest valleys, to a considerable height above the summit of Chimboraço, which has an altitude of 21,470 feet above the level of the sea. It is to be observed, however, that Humboldt must have been at a considerable elevation when this took place, and that this animal usually occupies situations of very considerable altitude; but still, when the rarity of the air is so great as it must be at the top of such elevated mountains, and which is indicated by the barometer being below 10 inches, the diminution of specific gravity, necessary to make so huge an animal be supported by air so highly rarefied, is wonderful.

CHARLES.

Is there any structure in fish, similar to that which is employed in increasing buoyancy in birds,

for the purpose of assisting them in swimming, or in their ascent or descent in the water?

DR. A.

There are air-cells in all fish which have the power of ascending or descending in the water: and such animals are able to compress their organs strongly, by means of appropriate muscles, so as to condense the air in the cells, or force some of it, as has even been supposed, into the stomach or gullet, from which it can escape from the body.

CHARLES.

I have never observed any thing like tendons in fish, as one sees in quadrupeds and birds: and I suppose they are unnecessary in them.

DR. A.

Their muscles are paler, and are of great force and magnitude; but as their motions are fewer, and as they have not limbs and joints, there is not the same occasion for arrangements to diminish bulk, at particular parts of the body. Their fins and tails are the organs by which they carry into effect their various powers of motion, through the medium of appropriate muscles.

I have already observed that there are many muscles in the human body which have no insertions in bones; bones are therefore by no means necessary to the existence of muscles, for there are

numerous animals which have no bones, as insects, worms, and the whole of those which are termed mollusca, which are capable of the most active and diversified movements, far beyond the proportion of what the higher orders of animals are capable of performing. The minuteness and number of the muscles which the bodies of the smaller animals possess, may be judged of from the account which Lyonnet gives of those of the caterpillar of the cossus. In the head, as Kirby and Spence inform us, he found 228; in the body, 1647; and enveloping the intestines, no less than 2186; which, after deducting 20, that are common to the gullet and head, gives a total of 4061. In the human subject only 529 have been counted; so that this minute animal has 3582 muscles more than the lord of the creation.—It is not, therefore, in the higher orders of animals that the beauties and the bounties of structure are alone discernible. The most minute insect exhibits a system of admirable provision and adaptation, just as much as the stupendous elephant, or even proud man himself.

HARRIET.

I have often been struck with the power which flies and insects have, of walking up perpendicular places, and even along ceilings, upside down. Is there any thing glutinous in their feet, which ena-

bles them to adhere so securely to a wall? But yet there seems to be nothing of a sticky nature left behind, that indicates such to be the case.

DR. A.

The circumstance which you mention is a very curious one, and was, for a long time, but little understood. It was not till Sir Everard Home had an opportunity of examining the Lacerta Gecko, a species of lizard, which is a native of Java, that any light was thrown on the subject. This animal was observed by Sir Jos. Banks to come out in an evening, from the roofs of the houses, and walk up and down, with perfect ease, the smooth, hard, polished Chinam walls, usual in that country, in search of flies, which are its common food. On examining the feet it was found, that this animal has five toes, at the end of four of which are sharp claws. At the lower surface of each toe, are sixteen transverse slits, leading to as many small cavities or pockets, with fringed edges; and connected with them is a curious structure of muscles, by means of which the edges of the pockets are turned down, and forcibly kept upon the surface on which the animal stands; while the muscles within, by their action, pull up the pockets, and produce a kind of vacuum which tends to keep the animal from falling.

CHARLES.

Then these little pockets may be considered in the light of suckers, which are acted upon by the will of the animal, so as to make a vacuum at pleasure, and thus by means of the pressure of the atmosphere, to render the animal adherent to any substance against gravity.

DR. A.

This is precisely the case; and Sir Everard found it to have a considerable analogy with what occurs in the echinus remora, or sucking-fish, which adheres to the bottoms of vessels. In flies and insects he found a structure exceedingly similar, a vacuum being formed, at pleasure, by means of suckers and appropriate muscles, attached to the lower part of the feet of the animal.

HARRIET.

How exceedingly curious and interesting this provision is, that the principle of the air-pump should be applied so extensively and so elegantly; but are there examples of a similar structure in larger animals?

DR. A.

The same plan has been found to be adopted in the hinder flippers or feet of the walrus, or sea-horse, which are made like gigantic webbed hands, and are furnished with muscles, which can raise

up the centre of the hand when laid flat, and thus make it act as a cupping-glass, to prevent the animal from falling back in its movements, whether on ice, or in climbing rocky cliffs. — Other animals use their claws in climbing, as cats; or their hands and feet, as monkeys; or their tails, as sapajous, a division of monkeys, and chamelions; while some birds, as woodpeckers, can support themselves against trees by the pressure of their tails, when they are employed in seeking their food in decayed trees, which furnish so many of the insects on which they live. — The form of the bodies of animals, and the disposition of their muscles, are adapted to the various motions which their greatly diversified modes of existence require; but you will hardly think that a particular structure is bestowed on some animals, for the purpose of giving them a facility of remaining stationary.

SOPHIA.

This would be very curious, for an animal is stationary when it does not employ its muscles.

DR. A.

And in most of the Mammalia class repose consists in the recumbent posture, when no muscles are employed; for you will observe that in standing, there is a continued action of the extensor muscles of all the joints; and that if this were to

cease, or be suspended from any cause, the animal would sink to the ground. — Some birds, however, have occasion to stand very long on one leg, as storks; and they, as well as perching birds, have a very curious conformation of limb, which I must mention to you, for the purpose of avoiding the necessity of long continued muscular action. The upper part of the stork's leg has a projecting piece of bone, which, when the leg is extended, is lodged in a sort of depression or socket in the lower part of the thigh, adapted to receiving it. It is obvious that by this mode, as the bearing is perpendicular, and as certain ligaments, like springs, keep the limbs together, they are in a state of attachment to each other, without the operation of muscles, and therefore without the fatigue of muscular exertion. The perching birds are able to maintain their hold of the branches of trees without constant attention, and to sleep in that posture. This they do by means of the tendons of the flexors or benders of the toes passing over the heels, and being so united to muscles arising near the upper part of the thigh, as to be acted upon, and thus to bend the toes, and make them grasp any particular twig, according to the pleasure of the animal, when the weight of the body, in perching, presses down the thighs and legs. At the same time the flexibility of the neck allows the head of the bird to be carried back

and placed under the wing, so as to bring the centre of gravity more over the feet, and therefore enable the bird to stand more steadily.

Before we take leave of the muscles, it is necessary that I should tell you something of the nature of muscular flesh, or fibre, as it is usually termed. — I have already stated to you, that the fibres of muscles are separated from each other by cellular membrane, a substance principally consisting of jelly or gelatine, the nature of which I pointed out to you, when we were on the subject of the integuments. Long continued boiling, or maceration in water, separates this jelly, and any other extraneous substance, and leaves the muscular fibre in nearly a pure state. We then find it to be a whitish, insipid, stringy substance, insoluble in water, and hardly at all putrescent. It is termed fibrine, and is considered as a species of condensed albumen. It is similar, as we shall afterwards find, to one of the most important component parts of the blood, and it has a material share in the nutriment of man, and of many other animals.

HARRIET.

It seems to be very remarkable, that a tasteless and insoluble part should be so important in nourishing the body. I should have thought that the boiling, which you speak of, would take every

portion of nourishment from the flesh which has been subjected to it.

DR. A.

I do not mean to say, that in the state to which it is brought by boiling or maceration, it would be well adapted for nourishment. At any rate it would not be an agreeable article of support: but in the form in which it exists as common flesh, its parts are so separated by the jelly, albumen, and other substances adhering to it, as to be more readily digested than it could be in its separate form.

HARRIET.

Then the particular flavour of animal food exists, I suppose, in the jelly which is obtained from the meat by boiling it.

DR. A.

If the broth is boiled down, so as to become a dry extract, and alcohol, or the strongest spirit, be poured on it, a portion of this extract is found to be dissolved, which is recovered on driving off the spirit. The part so recovered is what gives the particular flavour to meat, and has been termed osmazome. It is to be remarked, however, that fibrine, though insoluble in water, is soluble in some acids; and that, with nitric acid, it is converted into a very curious fatty substance, called adipocere, which has obtained a great deal of fame

in animal chemistry. The notice of this circumstance leads me to mention a very extraordinary spontaneous change which muscular fibre undergoes, when placed under certain peculiar circumstances.

At Paris there was a very large burying ground, called La Cimetière des Innocens, which had been, for a very long period, the receptacle of about 3000 bodies annually, which were buried in deep pits, containing layers of 1200 or 1500; and these covered over with earth, again and again, till there was an elevation much above the natural height of the soil. Complaints having been long made of the insalubrity of the air, by the continuance of this mode of inhumation, it was determined, in the year 1782, to remove the soil and its contents; and when this was set about, it was found that the corpses were not very offensive, and that every part, except the hair, bones, and nails, was converted into a sort of cheese-like substance, of a grey brown colour, not unlike spermaceti in texture. This change was effected by the putrefactive process going on in a confined place; and new combinations occurring, from the materials of which the body was composed, acting upon each other.—A similar change has been produced by the action of nitric acid upon muscles; and it is found, likewise, that if a piece of beef, or other animal substance, is exposed long in a running stream, it is converted

into a similar substance. The substance resembled very much that which I have mentioned, as being produced by the action of nitric acid on muscle.

These singular changes which can be effected in the state of the muscular fibre, gave to some gentlemen the hopes of being able to turn to use, and profit, the flesh of such animals as are not used as food, and are at present doomed to putrefaction; but the attempt has been long given up, on account of its having been found impracticable to purify the fatty mass sufficiently.

CONVERSATION VII.

OF THE BRAIN AND NERVOUS SYSTEM.

DR. A.

I HAVE already stated to you, that nerves are small white cords, of various sizes, which take their origin from the brain, or the spinal marrow, are diffused over every part of the body, and are the means by which sensations are conveyed, and the will exercised. The subject, however, requires more particular elucidation; and I propose it as the employment of the present occasion.

The brain is that particular organ which is placed in the head. It consists of two parts, one of which, the anterior and larger, is termed the cerebrum, or brain; and the other, which is the smaller, is seated at the lower part of the back of the head, and is denominated the cerebellum, or little brain; but, in common language, the whole contents of the head are termed the brain.

CHARLES.

Is the brain capable of being divided into different parts?

DR. A.

Most minutely; but I do not think this division will interest or instruct you; and I shall give you no more of it, than is merely necessary to afford a general view of the nervous system.

SOPHIA.

The brain must surely be exquisitely sensible, since it is the organ of sensation in the body?

DR. A.

In that you are mistaken. The substance of the brain is entirely devoid of sensibility, though it is the last apparent link in the chain of sensation; that, beyond which, further investigations have hitherto ended in nothing but idle and useless speculations. — The brain is made up of a kind of pulpy matter, grey in the outer part, which is termed the cortical or cineritious substance, from its external position and its ash colour; and white within, which is termed the medullary, from being of the white colour of marrow. Its external part is composed of what are termed convolutions, or doublings, like the puckers of dress; and the whole is protected by three membranes, or thin coverings, the two exterior of which stretch over the doublings; while the interior accompanies and covers every part of them, dipping down, and returning, for the purpose of passing on to the next convolution. These membranes are termed likewise the meninges of the

brain, and the outer is called the dura mater; the inner the pia mater; and the middle, from its being as thin and fine as a cobweb, the arachnoid coat. It must be observed, however, that the outer coat, the dura mater, which is very thick and strong, and which is firmly attached to the inside of the skull, and divisible into two laminæ, though it does not pass into the convolutions of the brain, yet forms certain expansions, called processes, which separate the hemispheres from each other, as well as the cerebrum from the cerebellum. It also forms, between its laminæ, certain cavities called sinuses, which answer the purpose of the larger veins in other places.

CHARLES.

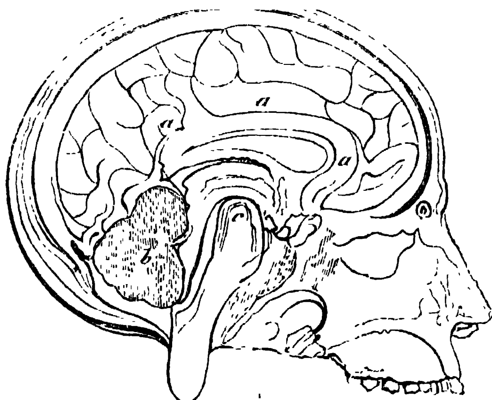
I cannot conceive what relation the names, *dura* and *pia mater*, can have to the nature or uses of these coverings.

DR. A.

They are fanciful enough; but the appellation of mater, or mother, is given, from their being supposed to be the source of all the other membranes; and dura, hard or firm, is applied to the outermost, from its great comparative firmness and tenacity; while pia, pious, natural, or affectionate, is applied to the innermost, from its taking the brain into its folds, and embracing it, as a good mother does her child. You will thus see that anatomists

have just been as fanciful, in their epithets, as astronomers, in the names which the latter have given to the different constellations. — The cerebrum is divided, vertically, from before backwards, into two hemispheres, or half spheres, called the right and left hemispheres. It is united at its lower part, to the cerebellum, and from them both proceeds the spinal marrow, which is, as I have before mentioned, the substance contained in the cavity of the back bone, or spine.

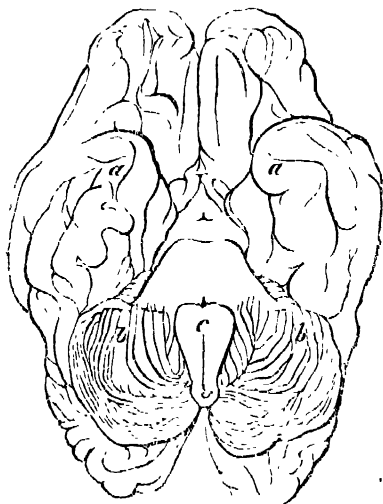
From the little sketch which I now show you, you will form an idea of the mode in which the cerebrum and cerebellum are distributed in the



head, this being a vertical section. The cerebrum occupies the whole upper part (*a a a*) of the skull,

and the cerebellum is confined to the very lowest and back part of it (*b*). In the cerebellum you will observe, that the medullary and cortical matter are so distributed, as to assume an arborescent appearance which has been called the tree of life, arbor vitæ. In the cerebrum, on the other hand, the external cineritious matter has more the aspect of a dark, undulating border, round a white centre of medullary substance. The medulla oblongata, or oblong marrow, (*c*), lies at the bottom of the cerebrum, immediately before the cerebellum, and is the term given to the spinal marrow, till it leaves the skull.

In another little sketch, you must suppose the



brain taken out, and placed with its base uppermost. There will then present themselves the brain (*a a*), the cerebellum (*b b*), the medulla oblongata (*c*), terminating in the spinal marrow (*d*).

CHARLES.

Is the brain entirely solid, and continuous, or has it any cavities?

DR. A.

It has four cavities or ventricles, as they are called, which contain generally a small, but in hydrocephalus, or water in the head, frequently a large quantity of fluid. The two first are denominated the lateral ventricles, the others the third and fourth, and they all communicate with each other: but of these, and various points in the minute anatomy of the brain, it is impossible to form any idea from description, and very little from even the best drawings. From the lower part of the brain, nine pairs of nerves pass off through small holes in the skull, principally to the organs of sense, and the muscles of the face, eye, forehead, and tongue. From the whole length of the spinal marrow, thirty-one nerves are sent out, from each side, through appropriate holes. These last, either separately, or in various combinations with each other, or with branches transmitted from some of the nerves of the head, furnish all the other external and internal parts of the body with the

influence which is necessary to the exercise of their respective functions.

CHARLES.

Does it appear to you, that there are any particular parts of the brain which may be considered as more especially the source of our feeling? I have heard of some notions relative to the pineal gland being the seat of the soul. I think it was Descartes's idea.

DR. A.

It was so; but this was nothing more than a vagary of the imagination. The pineal gland is, in truth, a very small glandular body, like a pea, very deep seated, and attached to the contiguous parts by a small peduncle. It is remarkable for always, in adults, having a portion of sandy matter in it, which is the phosphate of lime. But this circumstance, with very few exceptions, is confined to the human race. Some other parts of the brain have, with equal reason, been elevated to the same dignity which Descartes conferred on the pineal gland.

CHARLES.

Philosophers seem to have racked their ingenuity to discover a certain centre, or seat of sensation. Instead of making this in the centre of the head, which seems to be the natural position for it, Gall and Spurzheim, I think, place it in the very outside, and direct us to look for the seat of mental faculties in mere elevations of the skull.

DR. A.

Their ideas are speculative enough, but you do not quite understand their bearing. The elevations of skull are only viewed as indications of proportional elevations of brain, in which the organs of particular faculties are supposed to reside. The skull itself, being originally soft, was, as it were, moulded upon the brain, and took its shape from it; and on the surface of the various parts of the latter, it is supposed, that the organs of the various faculties are placed, forming certain projections, cognizable by means of the bony elevations formed upon them.

CHARLES.

But I have heard of various injuries of the brain, by which portions were lost, and yet the patient completely recovered. Now I do not understand how this could be the case, when, according to this doctrine, the removal of no part could occur, without the corresponding loss of an organ, or part of an organ.

DR. A.

The founders of craniology, cranioscopy, or phrenology, (for it is known by all these names), have anticipated, if not removed this difficulty, by stating, as a basis of the doctrine, that the organs are all of them double, and that in all the instances which have occurred of loss or destruction of any particular part of the brain involving an organ,

the opposite organ remained untouched, and was, therefore, sufficient to carry on its particular function, just as one eye will answer the purpose of vision, when the other happens to be lost. It is also to be observed, that though Gall and Spurzheim make the seat of the organs external, they deduce their origin from deep-seated parts, as I shall endeavour to explain to you.

I have already mentioned, that there are two particular parts, of which the substance of the brain is composed, the cortical or cineritious, and the medullary. Gall and Spurzheim consider the latter as fibrous, and suppose that it was derived from, or produced by, the cineritious substance, which they regard as the first that existed in the original formation of the brain, and as that which, by means of its numerous vessels, formed the medullary or fibrous part, in which last they likewise comprehend the nerves. They endeavour to show, that the fibrous matter is invariably the product of the grey or cineritious; and think they can trace the whole of both cerebrum and cerebellum, to the medulla oblongata, from which they imagine that they had their ultimate origin. In the whole contents of the head, as well as in the spinal marrow which descends from it, they state, that the grey, or cineritious matter, is so disposed, as to keep up the fibrous; and hence they infer, that the different parts of the brain and of the

spinal marrow; that the nerves which proceed from the brain, and which chiefly supply the organs of sense; that those which issue from the spinal marrow, and are principally devoted to the muscles; and that those which are distributed within the chest, and the cavity of the abdomen, have no common source, but that every part has its separate origin, and that the various parts now mentioned, are only brought into a sort of general communication with each other.

This is therefore a sketch of their anatomy of the brain and nerves. Now they suppose that there is a peculiar organization bestowed on different parts of the surface of the brain, just as there is to the organs of sense, in order to communicate to us the faculties of memory, imagination, and judgment, as well as of every other power and propensity which may be possessed. But as they deduce the brain originally from the medulla oblongata, they suppose that this is the ultimate origin of the particular organ, which is developed, and made fit for its office on the external surface of the brain.

CHARLES.

Then, in fact, we may consider the organ as extending from the medulla oblongata, and comprehended between two radii, terminating at the surface of the brain.

DR. A.

So it would appear; but then as the organ has

both width and breadth at the circumference or surface, it may be likened in some degree to a cone, having its apex in the medulla oblongata, and its basis at the surface of the brain. The whole of the system of organs has been compared, by phrenologists, to an inverted cone; but each particular organ seems to be a cone likewise, according to the description given of them; and in consequence of the space which they thus occupy, attempts have been made to note them by an instrument to which the name of craniometer has been given. This is, however, a refinement which originated with the disciples of Gall and Spurzheim, and not with themselves.

HARRIET.

I have talked with friends who attended Dr. Spurzheim's lectures when he was in this country, and were quite in raptures with organizations, developments, and manifestations. I should be very curious to have the seat of the different faculties pointed out; for, to confess the truth, I find it rather difficult to follow the anatomical description which you have given us.

DR. A.

I am glad that I have it in my power to shew you, from Dr. Spurzheim's craniological work, a side, front, and back sketch of a head: on which you will see that the situation of the different facul-

ties and propensities is designated by particular numbers. The respective organs are arranged in three divisions; namely, those relative to the *propensities*, which are situated on the lower part of the head, and are numbered from 1 to 9: those relative to *sentiments*, which are placed on its upper part, and are numbered from 9 to 18: and those relative to *intellect*, which have their seat in the fore-part of the head, and are numbered from 18 to 33. The limits of the respective organs are denoted by lines; but, in order to show you, at one glance, the particular position of the organs of the propensities, of the sentiments, and of intellect, I have made a broader line to denote the boundary of each of the general divisions of those organs.

The seven organs which relate to the propensities, with their respective numbers, are as follow:

No. 1. Amativeness;

No. 2. Philoprogenitiveness, or love of offspring;

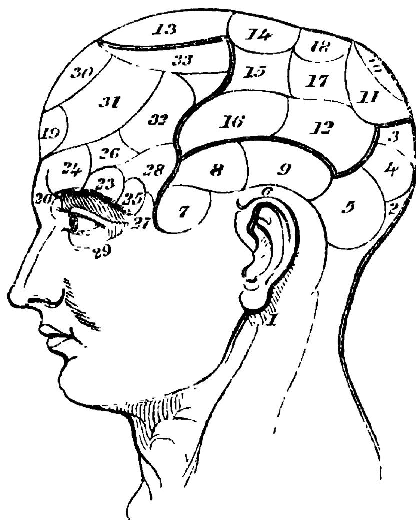
No. 3. Inhabitiveness, or the attachment to particular places;

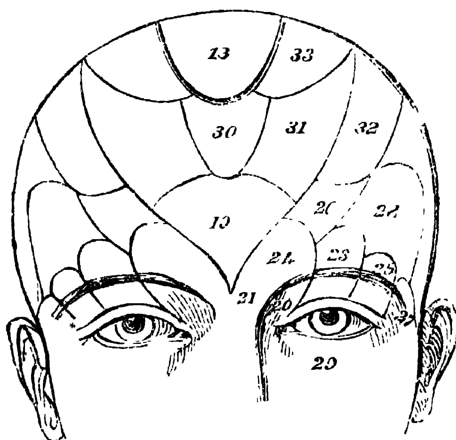
No. 4. Adhesiveness, or attachment to particular individuals;

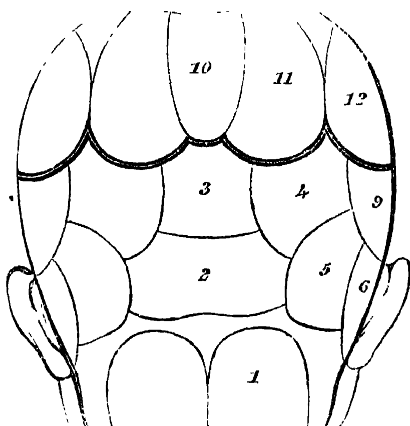
No. 5. Combativeness, courage, or the love of fighting;

No. 6. Destructiveness, or the propensity to destroy;

No. 7. Constructiveness, or the propensity to build;


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No. 8. Covetiveness, or Acquisitiveness, the disposition to covet, and to pilfer; and

No. 9. Secretiveness, that to conceal.

The nine next organs relate to sentiments, and are as follow:

No. 10. the organ of Self-love;

No. 11. that of the Love of Approbation;

No. 12. of Cautiousness;

No. 13. of Benevolence in man, or Meekness in animals;

No. 14. of Veneration;

No. 15. of Hope and Faith;

No. 16. of Ideality, or poetical talent; immediately above which is a blank space, which is supposed to be the seat of the organ of Wonder;

No. 17. The organ of Righteousness, or Conscientiousness;

No. 18. That of Firmness, or Determinativeness.

On the front of the head are the organs of intellect, which take cognizance of the existence and qualities of external objects; and therefore combine their operations with the five senses, hearing, seeing, smelling, taste, and touch, which form the means by which man and animals are more immediately brought into communication with the external world. The organs of intellect are,

No. 19. that of Individuality; or the desire and capacity to know facts and things;

No. 20. that of Form;

No. 21. of Size;

No. 22. of Weight;

No. 23. of Colour;

No. 24. of Space or Locality;

No. 25. of Order;

No. 26. of Time;

No. 27. of Number;

No. 28. of Tune;

No. 29. of Language;

No. 30. of Comparison; that of seeing resemblances, differences, and analogies;

No. 31. of Causality, or the love of metaphysics;

No. 32. of Wit; and lastly,
No. 33. of Imitation.

CHARLES.

What a curious assemblage is here brought together. Such a cluster of virtues and vices, sympathies and endowments, just as bewildering as are the stars on a globe, or in the heavens, to the uninformed in astronomy. But I am most astonished at the idea of the organs of crime; of a propensity to destroy, and a propensity to pilfer. According to this system, a culprit may put his hand to his head, and plead, in abatement of punishment, the protrusion of a well-developed cone, the manifestation of a full-grown bump. There would be no resisting his plea.

HARRIET.

Particularly when he could claim a sort of sympathy or fellow-feeling with the judge and jury; for if I understand the doctrines of craniology aright, the organs are common to all mankind; some persons only possessing a greater amplitude of particular organs than others.

SOPHIA.

But then you forget that what might be his justification, might, with a craniological judge or jury, be his conviction; for, among true believers, if evidence were at all dubious, there would be no

withstanding a well-marked elevation in a critical spot.

HARRIET.

But, Charles, I think the prisoners at the Old Bailey receive the reflection of a looking-glass upon them, in order to exhibit their countenances to the jury. This would be rather an unfair advantage given to an acute phrenological juryman; and as the English law is merciful in its application, such a power of inspection should not longer be permitted.

SOPHIA.

There is one mode, however, by which the measure which you propose, Harriet, would be rendered unnecessary.

HARRIET.

And what is that, Sophia?

SOPHIA.

By furnishing the prisoners with either wigs or night-caps.

DR. A.

Upon my word, good people, craniology is rather roughly handled by you. I must tell you, however, that you may save yourselves the trouble which you propose; for there is no discovering a projection which is covered with hair, unless by the touch; and, therefore, your fears for our criminal jurisprudence may vanish.

HARRIET.

But I think it must be admitted, that the detection, by whatever means it may be effected, of a well-manifested organ of covetiveness or destruction, would be a strong confirmatory proof of guilt.

CHARLES.

The Bow Street officers might, at any rate, get some important hints in their vocation, by attending to the seats of the propensities; and Sir Richard Birnie, Mr. Chambers, and even the Lord Mayor himself, might derive no little advantage in the detection of crime, if they would become zealous students of phrenology. I should not wonder, considering how numerously Dr. Spurzheim's lectures were attended in both ends of the town, and in all parts of the country, to hear, in no long time, of persons being taken up as suspicious characters, merely because they possess an unfortunate development.

SOPHIA.

Care must be taken, however, in such a case, particularly if the parties are Irish, that the development has not originated from the operation of a fist or a cudgel.

CHARLES.

As the organs are double, an examination of the other side would clear up the difficulty.

HARRIET.

But to speak seriously, I feel a great difficulty in considering virtues and vices as dependent on certain structure; and I should like to know how persons can be regarded as accountable for their actions, in whom nature has not only planted the seeds of virtue or vice, but actually brought them to great maturity. Is it supposed that any sort of moral control is capable of being exercised, which can affect the developement of certain organs?

DR. A.

Spurzheim says, that the inferior faculties should be subordinate to the superior, and that the victory which the superior faculties gain over the inferior, is virtue. If the combat is difficult, the merit of vanquishing is great, and if in all men, he adds, the superior faculties were eminently active, and the inferior less, and only proportionate, every one would do good from the love of doing so. One of his most able and zealous disciples, Mr. Combe, exemplifies the effects of education, by supposing two persons, in whom the organs are developed in an average degree, and one of them educated among people of sordid and mercenary dispositions, the other in moral and religious society. The first would have covetiveness and self-love highly cultivated, and therefore self-interest would be his leading object. The organ of love

of approbation might co-operate and produce the desire of distinction in wealth or power; and veneration, that of admiring the rich and great: while conscientiousness might be too weak to offer any control. On the other hand, with the second, the love of approbation would desire esteem for honourable and virtuous actions; and covetiveness would be viewed principally as the means of procuring gratification to these higher powers. Hence he considers, that the practical conduct of such persons might be very different, from this difference of training. One organ, it appears, must, therefore, be opposed to, or made to co-operate with another; but whether the effect of this is an additional elicitment of one organ which may be scantily, or the diminution of another which may be abundantly developed, does not quite appear.

CHARLES.

There is, I suppose, some connection traceable between the organs of sense and the brain; and I should be anxious to know whether, in phrenology, any apparent designation or division of organs exists, or any thing which can point out the termination of one organ, or the commencement of another.

DR. A.

All the organs of sense are constituted of an expansion of nerves, and in those which are

placed in the head, the nerves are traceable to the seat of the organ. Nothing of this kind can, however, be said of any of those organs which are described by phrenologists, and no particular divisions are apparent, except the mere elevation of the surface of the brain, which answers to the prominence externally. Such is the deduction, at least, which is made on an ordinary inspection of the convolutions of the brain; and this I believe was also the original idea entertained on the subject by Gall and Spurzheim.—Spurzheim, however, it must be observed, has stated in a late work, that he can at any time, by an inspection of any given portion of the convolutions of the brain, determine the particular part of the brain from which it has been taken, and, therefore, the particular organ to which it belongs. This is a minuteness of discrimination which is very extraordinary; and I should be exceedingly curious to see it put to the test.

CHARLES.

But are elevations of skull always necessarily indicative of corresponding elevations of brain?

DR. A.

Generally, but not invariably so; for at the eye-brows, for instance, the elevations are those of the walls of the frontal sinuses, which are cavities existing there, varying in magnitude in dif-

ferent individuals, and communicating with the nose. These elevations therefore do not evince the prominences of the brain within; for the inner surface of the projecting part does not come in contact with brain. The same happens, likewise, as to some of the projections near the basis of the skull, in the neighbourhood of the ear.

HARRIET.

Do the phrenologists think that there is any sort of analogy between the mode in which the dispositions of men and brutes are indicated? for I observe that the 13th organ is called that of benevolence in men, and of meekness in animals.

DR. A.

They certainly derive many of their facts and reasonings from considering the form of the brain in animals, as well as man; and, in particular, the whole of the organs which relate to the PROPENSITIES are considered to be in common to both.

The organ of *destructiveness*, they maintain, is possessed in a high degree by carnivorous animals; and by some of these more than others: for while certain animals only kill what they require for food, others destroy for the pleasure of the thing; just like a little naughty dog of Gall's, who used to watch several hours for a mouse, but would leave it as soon as it was destroyed. The organ is very large in lions, tigers, and

keen sportsmen; and was found to be greatly developed in the heads of Thurtell, Bellingham, Buonaparte, and King Robert Bruce; the skeleton of which last personage was discovered some years ago at Dumfermline, and the skull formed the subject of a long paper in the Phrenological Transactions.

The organ of *combativeness* is large in Charibs, and in the lower Irish; and was more remarkable in all classes, in former, than more recent times. King Robert Bruce had an ample organ of this kind. So have carnivorous animals, and game cocks; and last of all, that amiable specimen of the softer sex, the scold.

SOPHIA.

But surely you are not serious in the examples which you give us of the application of phrenology. Are such exemplifications actually to be found in authors?

DR. A.

Assuredly; and you ought to take the information very seriously, for it is so given. — The *love of offspring* is greater in women than men, and their peculiar organ is therefore larger. Of twenty-nine women who were infanticides, twenty-five had this organ very small. It exists in a considerable extent in cows, sheep, dogs, monkeys, and poultry.

Magpies and ravens carry away money and spoons, and gather stones, and similar things of which they cannot make use. Some dogs prefer bad bits, which they steal, to good dishes which are given to them: these animals, it is said, have the organ of *covetiveness* strongly marked. Spurzheim tells a story of a young Calmuck, who was brought from Russia to Vienna, by Count Stahremberg, and became melancholic and nostalgic, because his confessor, who instructed him in religion and morality, had forbidden him to steal. The confessor, in consequence, gave him permission to steal, on condition that he would give back what he had stolen. The Calmuck profited by this permission, and stole the watch of even his confessor, during the consecration of the mass, and leaping with joy, gave it back after the mass was over.

SOPHIA.

This boy must then, I suppose, have had a considerable organ of benevolence, and of conscientiousness?

DR. A.

Probably so; but as I am no craniologist, I cannot solve this point. — The organ of *secretiveness* is large in American Indians; in debtors, who wish to conceal their real situation from their creditors; in good actors, and in all cunning persons; in foxes; in cats, as evinced by their sly

mode of watching for mice, without moving a limb; and in all animals which, if pursued, hide themselves dexterously.

The organ of *constructiveness* exhibits itself in considerable developement in architects, sculptors, and all those who excel in mechanical arts. It was found large in the great Raphael; and, singular as it may appear, in the skull of a distinguished milliner at Vienna. It is ample in rabbits, which burrow; and in beavers, marmots, and field-mice.—But it is always to be observed, that phrenologists, in giving the same propensities to men, as brutes, make this distinction; that men have some peculiar organs, which modify the operation of those which they possess in common with the lower orders of the creation; and thus give them the power of exercising a degree of self-correction and control, of which the latter are incapable. Of these organs, the five last, which relate to SENTIMENTS, are given as examples, namely, the organ of *veneration* (No. 14.); of *hope* and *faith* (No. 15.); of *ideality* (No. 16.); of *righteousness* (No. 17.); and of *determinateness* (No. 18.).

The organ of *self-love* (No. 10.) is represented as being rather common with the English, and as making them appear, to the French, cold, haughty, and supercilious. It is stated to be remarkable in horses, turkeys, and peacocks. The French, on the other hand, are considered as

having more of the love of approbation (No. 11.); and as, therefore, appearing to the English, vain, ostentatious, and absurdly complimentary.— Dogs and horses are gifted with a large share of this organ; and the fair sex, in a greater proportion than men.

The organ of *cautiousness* (No. 12.) is also more amply developed in women than men; and many animals which are particularly circumspect, as the roe, stag, polecat, otter, and mole, have a large share of it. So have those which place sentinels to warn them of approaching danger, as the chamois, cranes, geese, starlings, and bustards.

Benevolence in man, and *meekness* in animals, are described as being indicated by a certain elevation in the upper part of the frontal bone. (No. 13.) Wild, ferocious, and untameable animals are flat, or have a hollow here; and this is likewise the case with such animals as horses, cows, and dogs, when they are ill-natured and vicious, of which there are occasional examples. The power of taming animals is supposed to be connected, partly with the possession of the organ of *benevolence* or *meekness*, and partly of the organ of *individuality* (No. 19.), which is one of those of intellect.

Of the organs of INTELLECT, the organ of *form*, or of that of distinguishing persons (No. 20.), was largely possessed by our late king, George III.

So it is likewise by many animals, and also by honey bees, who can distinguish individuals of their own hives from those of any other.

The organ of *space* (No. 24.) is said to be remarkable in astronomers, geographers, and travellers by sea and land; and it is to this that the faculty is attributed, which enables animals to find their way back to places from whence they may have been taken. Spurzheim mentions several curious examples of this kind: — A dog was transported in a carriage from Vienna to Petersburg, and after six months it returned to Vienna. — Another dog was transported from Vienna to London, but he found means to get back. He attached himself to a traveller in the packet-boat, and went with him to Mentz, where he left him, and returned to Vienna. — Another was carried from Lyons to Marseilles, embarked, and was conducted to Naples, but he came back to Lyons by land. — Another found again his former master in Suabia, after having left his new master in Hungary. — Pigeons likewise have found their way home, though conveyed 30 leagues in a sack; so has the falcon of Iceland, however carefully confined; for often the first time it is sent against a heron, it ascends vertically into the air, distinguishes its regions, and takes the direction of the north. It is to the same organ that the power of migrating, and

of returning with precision to the same place, is referred.

The organ of *tune* (No. 26.) is described as being possessed largely by musicians, and by singing birds, particularly the males; and all the other organs have exemplifications of their existence given in persons who are distinguished by the faculties with which they are supposed to be connected. — You will now be able to form an idea of what phrenology is, and of the kind of evidence by which the opinions connected with it are supported. Independently, however, of craniological considerations, respecting which you will easily see, that there must be much difference of opinion, Gall and Spurzheim (particularly the latter) are excellent anatomists, and have great merit in their dissections of the brain, which have excited considerable interest among those who are most conversant with the subject.

CHARLES.

Milton speaks of the full fair front of our male ancestor; and painters and sculptors, as well as poets, seem to have denoted, in every age, the possession of great talents, and high elevation of mind, by an elevation of forehead, though they, perhaps, thought nothing of the fulness of brain which is thereby indicated. Hence there appears to have been a sort of general agreement, as far as this particular point in phrenology goes.

DR. A.

Certainly; and many physiologists, it is likewise to be observed, have, before the time of Gall and Spurzheim, referred the existence of particular faculties to particular parts of the brain; for instance, perception and attention, memory, reflection, imagination, moving power, common sense, natural instinct, &c.; but all these attempts at phrenological geography were well described by the great Haller, as being equally weak, frail, and short lived. — Sir Everard Home has likewise conceded, in some degree, to the principle of such speculations, in referring some particular faculties to particular parts of the brain; as, for instance, memory to the cortical part of it, the communication of sensation and volition to a transparent mucus or jelly, which enters into the composition of both brain and nerves, &c.; but he is not, in my opinion, to be congratulated on the success of his speculations.

SOPHIA.

Do you apprehend that cranology leads to materialism? I have heard it much deprecated upon that score.

DR. A.

When we admit, as we must do, that there is a connection existing between mind and body; between the functions of the brain and vitality; be-

tween a certain organisation or structure, which enables the organs of sense to report the information derived from without, to a directing agent within; we leave the nature of this agent untouched by any speculation as to the number of senses or media, which nature, in her wisdom, has chosen to employ in obtaining information, or in exercising the functions of life or intellect. — The objections to craniology, as leading to materialism, does not, therefore, appear to be well founded.

CHARLES.

The illustrations which have been brought forward to exemplify the different doctrines of this science, have an aspect so very fanciful, and frequently seem to border so much on the ridiculous, that I cannot help considering this circumstance as likely to diminish the chance which the subject, whatever may be its intrinsic merits, has to obtain attention from the more judicious part of society.

DR. A.

This is not at all an improbable supposition; but we must defer the consideration of the remaining circumstances relative to the brain and nervous system till another opportunity.

CONVERSATION VIII.

THE BRAIN AND NERVOUS SYSTEM CONTINUED.

SOPHIA.

I WAS going to remark, at the close of our last conversation, my surprise, that considering the great importance of the brain, portions of it should have been lost, and yet patients recover.

DR. A.

Injuries to this organ are always necessarily of a serious description: they are principally so, however, when there is any pressure upon it; and therefore in cases of fracture of the skull, the principal danger arises from the pressure, either of bone or of effused blood, which it is the intention of the operation of trepan or trephine to remove.

CHARLES.

What is the nature of this operation?

DR. A.

It consists in the use of a circular saw, by means of which a piece of bone is removed, of the size of a shilling; and by the repetition of this

operation, if necessary, room is given to let out effused blood, and to separate or elevate depressed pieces of bone, which press on the parts below. The trephine is a sort of centre bit; but it is to be employed with much care and delicacy. Its derivation from a Greek word, to turn, is obvious. Sudden injuries operate strongly; but various alterations in structure, provided they are gradual, may take place, without either the suffering or the disadvantage which might be imagined, when so important an organ is affected. I may mention, by the way, a very curious effect which an injury on one side of the brain frequently produces; and that is, a loss of power, not of the muscles of the same, but of the opposite side of the body to that in which the injury takes place.

CHARLES.

That is very extraordinary: then it appears that there is some sort of an interchange, or crossing of the nerves, or material of the brain, so as to occasion this singular phenomenon.

DR. A.

This must, of course, be the case; but the precise place where this crossing is effected, or the mode of its occurrence, is not altogether known. Anatomists have supposed, that because there is a sort of apparent interlacement in the upper part of the spinal marrow, the interchange takes place

there; but this does not seem to be case; for some parts which are supplied by nerves sent out from the spinal marrow, previous to this interlacement, are subject to the same law.

HARRIET.

Does the magnitude of the brain bear any sort of proportion to the capacities or abilities of the animal?

DR. A.

In some degree it does: but physiologists have not been able to lay down, with accuracy, any law upon this subject. Singular as it may appear, man has a larger brain, in point of absolute magnitude, than any other animal, with the exception of the elephant.

HARRIET.

What, larger than the horse, or the cow, or any of the larger quadrupeds?

DR. A.

Unquestionably; for if you look at the skull of any of these animals, you will see that its compressed, narrow, and elongated form allows but a small space for containing brain. Thus the largest brain of a horse weighs not more than 1 lb. 7 oz., while the smallest brain of man weighs 2 lb. 5 oz., and that of a child, not a great deal less. —Aristotle and Pliny made this important observ-

ation relative to the great magnitude of the brain of man; but some have likewise attempted to show, that the proportion of the brain to the rest of the body is greater in man than other animals.

CHARLES.

This would, I think, seem to follow from the actual size being greater.

DR. A.

Not exactly so; for in a small animal, you would expect to have a brain of less weight than in man, and yet its proportion to the weight of the animal might be greater. In point of fact, though this holds with regard to the larger animals, it does not with regard to many of the smaller. The human brain is about $\frac{1}{35}$th part of the weight of the whole body, while that of a horse is about $\frac{1}{700}$th part; of an ox, $\frac{1}{750}$th; of a sheep, $\frac{1}{350}$th; of an elephant, $\frac{1}{500}$th. On the other hand, in many apes, the proportion is from $\frac{1}{100}$th to $\frac{1}{22}$nd; in the dolphin it is $\frac{1}{25}$th; and in some birds, as the canary bird, is even as large as a $\frac{1}{14}$th.—The hopes, therefore, of physiologists, as to the discovery of the particular law on this subject, was disappointed; but it has since been remarked, and with every appearance of truth, that the size of the brain in man, compared with that of the nerves which proceed from it, is greater than in any other animal yet known. We know too little,

however, of the particular functions of the brain and its various parts, to be acquainted with the precise application of this fact; and, indeed, all the knowledge which we possess on this subject, shows how ignorant we are, as to the inscrutable connection which exists between vitality and corporeal function.

CHARLES.

I suppose there is some resemblance between the nature of a nerve, and that of the brain.

DR. A.

Microscopic observations have made it probable, that both the brain and nerves consist of minute globules, held together by a soluble, transparent, coagulable jelly, or mucus, which Sir Everard Home, as I have already mentioned, considers to be the medium through which sensation and volition are communicated. The nerves are divided into minute fibrils, having a delicate covering from the pia mater, and the whole invested with condensed cellular membrane, as an external covering. —It has been supposed by many, that the brain is a secreting organ, and that a substance called nervous fluid is produced by it, which is conveyed along the nerves as tubes. Others have conceived, that the nerves act by communicating vibrations of different descriptions and degrees of force to the brain; and others, that nervous energy is a sort of electric

aura, or influence, of the most subtle description, to which the nerves act as conductors. These hypotheses may be ingenious and amusing, but they are visionary, and totally useless, except as far as they may lead to the discovery of new facts. I shall have occasion to notice to you the operation of galvanism on some of the functions of the animal body, particularly digestion, which have been considered as favouring the last idea.

CHARLES.

It appears from what you have mentioned concerning the properties of nerves, that they exercise, at the same time, several distinct functions; they communicate sensation from without, and convey the power of motion, and the will to carry it into operation, from within. Is there any thing known concerning this division of function? One would be tempted to imagine that there were different nerves, appropriated to purposes seemingly so different.

DR. A.

If that could be substantiated, it would be one of the most valuable additions to our knowledge of the nervous system which has ever been made. It has, indeed, frequently been imagined, both in ancient and modern times, that some nerves serve for sensation, and others for motion; and that both of them, though distinct in their origin, unite to-

gether in trunks, and accompany each other to the different parts of the body; but such ideas were little more than speculative. A distinguished physiologist of the present day, however, Mr. Charles Bell, whom I have already mentioned to you as the author of the interesting work on the Anatomy of Expression in Painting, has, by an ingenious and highly creditable train of anatomical investigation, rendered them exceedingly probable. It will not, perhaps, be carrying you too much into detail, to tell you, generally, what his ideas are on so obscure and interesting a subject. — He supposes that there are, besides the nerves of sense, four distinct systems of nerves combined into a whole, viz. nerves of sensation; of voluntary motion; those connected with respiration; and, lastly, those which are conducive to animal existence, or nutrition, growth, and decay. These nerves he states to be sometimes separate, sometimes bound together, but as never, in any case, interfering with, or partaking of each other's influence. You will see by this little sketch, the mode in which he considers filaments of nerves for different purposes as bound together; A being a nerve, consisting of distinct filaments; B, one of the threads dissected out from it.



CHARLES.

But then has he traced any of these nerves to their termination, so as to make out the functions which they exercise?

DR. A.

This he has done in many instances, and is satisfied as to the accuracy of his conclusions.— He considers the spinal marrow as consisting of two parts, one right, and the other left; and each of these parts as consisting of three columns, the anterior for motion, the posterior for sensation, and the middle for the actions of respiration. The various parts which are supplied from the spinal marrow are therefore furnished with compound nerves, or rather bundles of nerves, of different descriptions, which, at their extremities, are divided so as to furnish sensation or motion, as the case may be. If a nerve of sensation is divided, sensation, and not motion, will be lost; and if a nerve of motion, motion, but not sensation; and if that part of the spinal column should be injured, which gives rise to one or other of these systems

of nerves, the nerves which arise from them, whether of sensation or motion, will entirely lose their power.

CHARLES.

This is a very interesting view of the subject, and certainly removes the difficulty with regard to a certain independence of sensation and muscular power on each other. But, then, are we to view, according to Mr. Bell's idea, the spinal marrow as another brain, giving influence and power to the nerves arising from it, independently of its connection with the brain?

DR. A.

Mr. Bell traces the columns of spinal marrow which belong to sensation and motion, upwards to the brain itself; and hence he infers, that these columns deduce, from the latter, their ultimate energy. From these columns within the skull, he likewise traces the origin of such of the nerves which are sent out by the brain, as are destined for communicating sensation, or muscular power, to the face and head.

HARRIET.

You spoke of a third column of the spinal marrow, that which was appropriated to furnishing the nerves of respiration; but I cannot understand why there should be any occasion for a separate class of nerves for this function, since respiration

is a voluntary effort, which we have the power of stopping at pleasure.

DR. A.

We have, unquestionably, a certain voluntary power over the act of respiration. We can stop our breathing to a certain extent; we can breathe more or less rapidly, and have the faculty likewise, of employing it in accomplishing some other operations, as those of smelling and speaking; but then we know that during sleep, and insensibility from disease, respiration goes on independently of the will; and that even with the possession of full consciousness, we are unable to repress coughing, sneezing, crying, laughing, and vomiting, in all which phenomena, the muscles which are subservient to respiration, and which you will find when I treat of that function, are very numerous, are more or less concerned. Mr. Bell, therefore, considered it as necessary that these muscles should have a peculiar set of nerves, for associating them together in the various actions of respiration.

SOPHIA.

But there are, then, nerves supposed to be possessed, over and above the usual nerves of sensation and motion?

DR. A.

Certainly; the muscles in question have the ordinary demands of other voluntary muscles on

the nerves of sensation and motion, and the respiratory nerves he conceives are superadded. Mr. Bell observes, likewise, that animals which do not respire, are without this set of nerves, and that, as the functions of these nerves are independent of reason, and are capable of being exercised independently of the brain, or when separated from it, the column from which they are derived does not extend to the brain, but is lost in the medulla oblongata, the upper part of the spinal marrow. He has satisfied himself, that five nerves which come out from the central of the three columns which I have just mentioned, near the commencement of the medulla oblongata, are destined to that function, and infers that the remainder of this central column, through the whole extent of the spinal canal, supplies roots to the spinal nerves, so as to give them an association with the action of respiration.

CHARLES.

If we can conceive a muscle to be deprived of its sensitive nerve, and to retain its motive nerve, there would be a considerable difficulty as to our knowing how the muscle was affected, as volition from within could not be assisted by sensation from without.

DR. A.

This would certainly be the case, and so it has happened in the very few instances of this kind which have been mentioned by authors. In one,

a man who had lost the power of sensation in his hands and feet, but retained that of motion, was able to grasp pretty firmly; but in holding any thing was apt to drop it, if his attention were at all called away. In another, a female with a similar affection, was continually dropping various household articles on turning her eyes aside, which she could hold in safety as long as she looked at them.

Mr. Bell, too, found in a patient of his own, a female, in whom the nerves which imparted sensibility to the eyes and eyelids, had been pressed on by a tumour, which, however, did not affect the nerves of motion, that she could open and shut the eyelids, but she could not tell whether they were open or shut. From this and other considerations he deduces the very reasonable conclusion, that muscles require both species of nerves, which form a sort of circle between them and the brain; and that while one nerve conveys the influence from the brain to the muscle, another gives the sense of the condition of the muscle to the brain.

CHARLES.

You have mentioned, that there are nerves which supply muscles that are obedient to the will, and others which are appropriated to such as are partly voluntary, and partly involuntary muscles. But is there a particular set of nerves which are devoted to the muscles which you have named

to us as being entirely involuntary, such as the heart, the stomach, intestines, &c.?

DR. A.

Your question involves several points of great consequence in physiology. It has long been observed, that all the muscles, or muscular structures, which are independent of the will, are supplied from a particular nerve which is termed the great sympathetic nerve of the body, and has no immediate origin from either the head, or the spinal marrow, like the nerves of sensation and volition. This nerve is derived, in the first instance, from a small branch proceeding from one of the nerves of the head, and receives accessions from branches derived from all the nerves which it approaches, whether those of the head, neck, back, or loins. It is thus connected with all the other parts of the nervous system, as its name imports; but it is, to a certain degree, independent of them; forming a system of itself, and being destined to the supply of those functions which are too essential to life to be left under the influence of the will. — I may mention, likewise, that in various parts of the nervous system, the nerves are interwoven with each other, in a sort of network, called a plexus, the object of which seems to be, the prevention or diminution of eventual disadvantage, from any injury to a nervous trunk.

There are also, in various parts of the nervous system, small knots called ganglions, which seem to be made of a mixture of medullary and cineritious matter. Nervous fibres run into, and are lost in them; and others proceed from them; but it is observed that the latter are more numerous than the former; and hence it has been supposed, by some physiologists, that ganglions are to be viewed as a description of minor brain, and as therefore connected, in some way, with the production or increase of nervous energy. No satisfactory opinion has, however, been hitherto formed relative to their use in the animal economy. But both ganglions and plexus seem to have an important influence in producing the sympathy which exists between various parts of the body.

HARRIET.

What an extensive and beautiful system of operations is carried on throughout the animal body, by means of these small white threads; and how admirably nature seems to have provided, by their means, for an extensive sympathy of one part with another, over the whole machine. But have all orders of the animal creation brain and nerves, like man, and the higher descriptions of animals? or does nature provide other modes of producing the same effect?

DR. A.

I have already mentioned to you, that in man

the magnitude of the brain, compared with that of the nerves, is greater than in any other animal. The higher orders of animals, (those with vertebræ, which include the mammalia, birds, many fishes, and serpents,) have likewise brain, spinal marrow, and nerves, which vary in their proportions to each other, and in many points of organisation; but many of the lower orders, as worms and insects, have merely one or two longitudinal nerves in the centre of their bodies, having in them various knots, or ganglia, from which other nerves proceed; and having, some of them, at one end, a slight enlargement, which may be considered as a brain. This is the most simple form of nervous structure, and resembles, in some measure, that particular part of the nervous system, the sympathetic nerve, which exists in the higher orders of animals; but while in the latter, the sympathetic nerve is solely applied to the organs concerned in the natural functions, namely, those of growth and nourishment, the longitudinal nerves exercise, in the lower orders of the creation, all the functions of the nervous system which are necessary to sensation, muscular motion, and the support of the animal. These animals may, indeed, be considered as having nerves, or rather brain, universally diffused over them; and many of them, as they are liable to accidents, possess a power of repair and reproduction, which is exceedingly wonderful.

SOPHIA.

I was much struck with the reproduction of the claws of lobsters and crabs, which you mentioned to us: are there animals which go further than them in the possession of this power?

DR. A.

To a very great extent; and the lower we go in the scale of creation, the more surprising is the reproductive faculty. How liable is the earth-worm to be injured by the unconscious gardener; but the injury, so far from diminishing animal life, increases it; for each portion into which the animal may be divided by the spade, becomes a separate creature, having a separate system of parts speedily regenerated. The head of the common snail, with its four horns, has been satisfactorily ascertained to be renewed in the course of six months; and in an animal of a more complicated structure, the water newt (the lacerta palustris), a complete eye was re-formed in the course of ten months, with all its various parts. The star-fish and anemone may have their tentacula removed, and they are speedily replaced; and if these animals are divided, two or more distinct animals are the consequence. But the fresh-water polype affords the most extraordinary example, of any known, of this wonderful power: for in whatever way it may be cut or divided, each part becomes,

in a few days, a separate animal, capable of all the functions of its parent. This animal is of a soft nature, like a common snail. It adheres by one end, like a sucker, to water plants, and other substances; and the other end, which is the head, is surrounded by many little arms or feeders, which seize and bring to the mouth, around which they are placed like radii, minute worms and water insects.

SOPHIA.

How very wonderful is this power; but we can hardly imagine that when such results take place from the accidental injurics of such creatures, they can have the same degree of sensibility as the higher orders of the animal kingdom.

DR. A.

We are, I think, entitled to infer that they have not; for nature, in providing for their preservation, and even extension, would hardly do this at the expence of so much suffering as would take place, if a worm, or a polype, underwent as much suffering from injury, as a man, or a quadruped. With the latter, insensibility and death are the result of severe injuries; and the beneficence of the Creator would not doom his creatures to those exquisite sufferings which must precede reproduction, if sensibility existed in the lower orders of

animals, to an extent similar to what it does in the higher.

Some of the animals which I have just mentioned, as star-fish, have no apparent nerves; but it may still be presumed, that they have something analogous to them, since the possession of sensation seems to be necessary to vitality; and sensations and various other functions of life are, invariably connected, in other parts of the creation, with a nervous system.

CONVERSATION IX.

OF THE ORGANS OF SENSE.

SMELL AND TASTE.

DR. A.

After having given you a general view of the brain and nervous system, I shall now pursue the subject into the organs of sense. By those I mean, the particular organs with which nature has endowed us, for the purpose of communicating impressions from without.

SOPHIA.

You mean, I suppose, hearing, seeing, feeling, smell and taste.

DR. A.

I do so; and it is by means of these organs generally, and by their particular modifications in different animals, that many of the various characters in the animal creation are produced.

CHARLES.

You mentioned that the nerves proceeding from the brain supply the organs of sense. You mean,

then, that certain nerves are distributed to these organs, so as to give them their particular fitness to receive and communicate impressions.

DR. A.

Certainly. The nerve of sight, or the optic nerve, is diffused over the retina of the eye, for the purpose of receiving the rays of light upon it, and transmitting the impressions which they produce, to the brain. The olfactory nerve is diffused over the membrane of the nose, in order to produce smell; the nerves of taste, over the tongue; those of hearing are spread into the interior parts of the ear; and the whole surface of the body has a delicate and extensive diffusion of nerves over it, which impart sensibility.

HARRIET.

Then, I suppose, there are differences in these nerves, by means of which they are capable of receiving one kind of impression, and not another.

DR. A.

That there are differences, we are very sure; but in what they consist, we know nothing; except, perhaps, that we can perceive some little dissimilarity of appearance in some of them, which in no way resolves the difficulty. Nature has imparted to the nervous expansion of different parts, different faculties; but why the retina, which is the

sensible part of the eye, should be capable of solely transmitting to us perceptions of sight, and not of smell; and why the faculties of the auditory nerve should be appropriated to hearing, is an ultimate fact for which we can give no account.

CHARLES.

May there not be a certain organisation of these parts, to which they may owe their respective faculties?

DR. A.

This may be the case for any thing that we know; but it would not remove the difficulty, if it were proved; for organisation is only another expression for minute structure, and if we could ascertain this ever so correctly, we still should be ignorant why the structure was connected with the possession of certain properties. The Creator has chosen to implant peculiar faculties on particular parts, and to connect with them certain varieties of structure and appearance; but there is no reason, except his will, that the skin should not see, or the ear smell.—It is necessary now, however, to enter into some details on the individual organs of sense, and I shall first consider the ORGAN OF SMELL, which I take first, merely because the nerves which are termed the first pair are devoted to this particular organ.

In the upper part of the face, there is a fine structure of thin, slight bones, covered with a fine membrane, called the Schneiderian or pituitory membrane, on which the olfactory nerve is diffused. These bones are of the thinnest and most fragile description, and are only intended as a sort of frame-work for the membrane to be spread over. They are protected from external injury by the firm and strong nose and cheek bones; but when any disease attacks them from within, they are very liable to serious molestation. The air conveying with it the subtle particles which constitute the materials on which smell is exercised, is applied, during inspiration, to the delicate and sensible olfactory organ; and thus the sensation produced, which has so constant a connection with the production of what is agreeable or unpleasant to us.

SOPHIA.

Are the nerves divided and subdivided on this membrane till they become invisible threads?

DR. A.

The olfactory nerve differs from most others, in being of a pulpy nature; and the expansion is therefore sooner lost than in many of the other organs of sense.

SOPHIA.

Some animals have great nicety of smell; is

there any peculiarity apparent in them, which gives rise to such additional perfection of sense?

DR. A.

The membrane on which the nerve is expanded, in such animals, is of larger surface, which arises from the peculiar bony structure which it covers, occupying a greater portion of the skull; and its divisions, or cellular structure, being therefore more extended. You may readily infer this, from the greater capacity of the nostrils, and the bones immediately contiguous to them, in hounds and pointers, which are remarkable for their smell, than in the greyhound, in which the nose is pointed, the face very flat, and the space appropriated to the expansion of the nervous matter very small. The hedgehog, the mole, the weasel, the bear, and the elephant, have a large space devoted to the convolutions of the pituitory membrane; and all these animals are remarkable for the acuteness of their smell. The seal is also very peculiarly gifted in its extent of smelling surface; and as this animal spends much of its time in the water, where the irritation of the water in swimming, particularly in a swift movement, might injure the sensible surface of the inner part of the nose, it has the power of closing up the opening into the nostrils, to prevent the inconvenience.

CHARLES.

One would think that the passage of the air through the nostrils, was likely to dry up the moisture, and therefore diminish the sensibility of the organ.

DR. A.

It would certainly do this, if it were not for a continual secretion, as well from the membrane itself, as from its expansion in various contiguous cavities. In the forehead, and in the jaw-bone, are cavities, called sinuses, which are lined with a continuation of this membrane. They thus afford, by their continual secretion, a fluid, which gradually distilling out of them, preserves the delicate membrane, on which the olfactory nerve is expanded, in continual fitness for its function. You may feel, in a common cold, a sense of fulness and weight on the forehead, which arises from a slight inflammation of the membrane lining two small cavities placed at the upper part, and near the centre of each orbit, and communicating by small openings with the cavity of the nose. These sinuses hardly exist at birth, when indeed the whole olfactory organ is but very imperfectly evolved. They may be considered as giving, in some degree, vibration and tone to the voice; and the openings into them are so placed, that the secretion which they produce may have an exit from one or other of them in every position of the body.

SOPHIA.

I have heard of persons having discharges from their brain through the nose. Such a thing must be of a very formidable description.

DR. A.

So it would be, if it were the fact; but these discharges are either from the increased or altered secretions of the sinuses, or the cavity of the nose; or from some affection of the delicate bones connected with the olfactory organ. The existence of such discharges from the centre of the head, was credited, even by medical men, till they became better acquainted with the anatomy and pathology of the parts.

CHARLES.

As the air which we inspire does not pass through these sinuses (for they seem from your description to be all of them culs de sacs), they are, I suppose, little connected with the exercise of smell?

DR. A.

They have acute sensibility, but it does not appear that the olfactory nerve is diffused over them, so as to constitute them a part of the organ of smell, probably for the reason which you mention.— The odorous particles of bodies must be of a very minute nature, when I tell you, that musk and

ambergris may diffuse a continual, and strong odour, for a long period of time, without suffering any diminution of weight. Haller found, that one grain of ambergris imbued 8000 square feet of paper with its peculiar odour, which was not lost during a period of 40 years: and you may readily conceive how minutely some substances are capable of diffusion, and how exceedingly small a portion is cognisable to the senses, when I tell you, that the same great physiologist calculated, that less than the two thousand millionth part of a grain of camphor is distinctly perceptible when diffused in air. Lord Valencia mentions, that the perfumes of Ceylon are to be discovered at nine leagues from it.

CHARLES.

The effluvium left on the ground by an animal passing over it, must be of an extremely subtle nature; yet it is palpable to dogs, and other hunting animals. I have often been astonished at the acuteness of their organs, so much beyond that of which we have any idea from ourselves.

DR. A.

This is a matter of profound admiration; and with dogs, it will even go to the extent of tracing out their master by scent, among many other persons. Birds seem also to have a very acute smell; and it is said by Shaw, that the burouras, or large

horned owls of the desert, during the existence of the plague at Algiers, used to hover over the town, and even pitch on infected houses; but they returned to their native deserts after the distemper ceased. Marvellous accounts have been given of Asiatic birds having been attracted to the plains of Pharsalia, after the celebrated battle which decided the fate of Rome.

HARRIET.

We hear of various savage tribes, among Indians, being endowed with a fine sense of smell. It would appear, therefore, that it is capable of being improved according to circumstances.

DR. A.

Many such accounts are given by authors; and I have no doubt that greater attention to the objects of perception will tend to cultivate its power; but it is even said that the olfactory organs are developed, in an extraordinary manner, in the individuals of some of those tribes, as if the necessity for the exercise of such faculty increased the actual quantity of the organ. Blumenbach, in his plates of skulls, gives the head of an American Indian chief, who was executed at Philadelphia, about the year 1760, for murder, in which the cavity of the nose was of extraordinary magnitude. He also mentions the skulls of some negroes as having larger nasal organs than are usual in human heads.

We have seen that domestication produced various changes in the characters and forms of animals; and that considerable alterations may likewise be effected by civilisation among the human race. It is to be remarked, however, that among Blumenbach's heads of negroes, there is a very great diversity in form, in elevation of forehead, in the facial angle, and in the magnitude of the nasal organs.

SOPHIA.

The sense of smell is, I suppose, universally given to animals; but there are some which do not breathe, as fish; where does the organ lie in them?

DR. A.

Most animals have the organ of smell; and those which are dependent on it in a principal degree for discovering their food, possess it in greatest perfection. Thus hunting animals, as we have seen, are of this class; and so are the graminivorous, which are, by their smell, led to the particular plants which are most suitable and acceptable to them. Fish have the nerves of smell diffused over their snouts, in order to give assistance to the organ of taste; but it may be observed, that the whale has no olfactory nerve, and seems to be entirely destitute of any organ of smell. The precise position of the organs of smell in insects

and worms is not known, though it has been ascertained that these animals are endowed with this sense. The spiracles, or breathing pores, which are openings that serve the purpose of the mouth, to admit air into the body of the animal, have been, in the former, regarded as the probable seats of the organ of smell: but Kirby and Spence, the authors of the delightful work on Entomology, which is so deservedly a favourite with the public, are of opinion that this sense is placed near the mouth.

The ORGAN OF TASTE has much connection with that of smell. By smell we are directed to what is grateful and salubrious; and by taste we derive a gratification in taking food, which insures our attention to the nourishment of our bodies, and therefore to the preservation of our health and existence.

CHARLES.

Is there any particular nerve which is appropriated to taste, as to smell?

DR. A.

Anatomists have not been quite agreed as to the particular nerve in which the faculty of taste resides; for the tongue, which, in man and some other animals, is the prime organ of taste, has likewise other duties to perform, for which it has a curious structure of muscles, which, in their

turn, require nerves. It appears, however, that the nerve of taste is a branch of the fifth pair, which is the nerve that gives sensibility to the face.

The tongue is composed of an assemblage of muscles, which are necessary for performing all the minute motions required in speech. It is covered, as the other parts of the body are, with skin and cuticle; but from the skin arise small elevations, or papillæ, most numerous on the point and edges, which are very vascular, and on which the extremities of the gustatory nerve terminate. Anatomists distinguish these papillæ by particular names, from their supposed shape or appearance, as pyramidal, fungiform, and conoid.

CHARLES.

The continual moisture of the mouth is doubtless intended to keep the organ of taste in proper order for its exercise?

DR. A.

Certainly; for you may observe that when the mouth is dry and parched, the power of tasting is lost, as happens on sleeping long with the mouth open.—For the purpose of taste, it is necessary that the food should be to a certain degree dissolved, or softened; for it could not otherwise enter into the inequalities of the tongue's surface, so as to give rise to the perception of taste.

SOPHIA.

Does the tongue then produce the spittle, or fluid, which keeps the mouth moist?

DR. A.

There is so much required for the purpose of lubrication, and also for moistening the food, during mastication, that besides the continual secretion of a fluid, which takes place from the mouth, in common with all other cavities, there are peculiar organs, or glands, situated in or near the mouth, which are destined for the secretion of the saliva, and which throw it into different parts of the mouth, by means of small ducts or tubes. Two of these glands, the parotid, are situated at the side of the face, and ascend upwards about an inch and a half from the angle of the jaw. An inflammatory swelling of these glands constitutes the mumps. Two others are situated under the lower jaw, called the submaxillary, and two under the tongue, called the sublingual.

SOPHIA.

Are these ducts which you mention capable of being discovered in the mouth?

DR. A.

A nice and experienced eye may detect them; but the flow of the saliva which they throw in is so gradual, as not to be capable of being discovered. A wound in the duct of the parotid gland,

when it runs along the face, is difficultly healed, on account of the continual stillicidium of saliva which takes place through it. Animals living in water are without this apparatus, which is obviously unnecessary in them.

CHARLES.

The power of habit seems to reconcile the taste to the most varied descriptions of aliment; whether it be the train-oil and the raw whale of the Esquimaux; the horse-flesh of the Tartars; or the greatest culinary refinements of civilised society.

DR. A.

This is wisely ordered by nature, in order to fit man for all the positions which he may have on the globe, and for the changes of abode which may occasionally be necessary for him. In animals, too, there is a certain latitude afforded to taste, according to the circumstances in which they may be placed; and we shall afterwards find, when we come to the subject of digestion, that ruminant animals, as cows, will occasionally reconcile themselves to a diet very different from their ordinary one.

CHARLES.

Is the tongue the only organ on which the nerves of taste are diffused? for it would appear, that in tasting, we employ both the tongue and the roof of the mouth, though this may, indeed, be merely for the purpose of applying the thing tasted to the papillæ of the tongue.

DR. A.

I believe it is principally with this view; though it has been thought that the nervous expansion extends in some degree to the palate, sides of the mouth, and lips. But it may be found, that if a portion of sugar, salt, or any other sapid substance, is rubbed on the tongue with the finger, the taste of the particular substance is distinctly perceived; on the other hand, this is not the case if the same substance is applied in a similar way to the palate, or any other part of the inside of the mouth. Blumenbach, however, mentions the case of a man who was born without a tongue, but in whom the distinctions of salt, sugar, and aloes, were readily perceived, and were expressed in writing, when any of these substances were rubbed on the palate. Here, however, it is not improbable, that some branches of the gustatory nerve might be communicated to the palate, in the absence of the organ on which they were usually bestowed.—The tongue appears to be an organ of taste in most animals: and in some of the graminivorous, it has elevations, directed inwards, which assist them in tearing up grass. Other animals, of the cat kind, have the tongue armed with sharp, strong prickles, which aid them in holding their prey. With some animals this organ is principally, if not entirely, intended as a means of procuring their food. The ant-eater, for example, thrusts its long hard tongue

out, and waits till a sufficient number of ants settle upon it, when it draws it in, and swallows them whole. The chamelion's tongue is likewise very long, and is covered with a viscous secretion, by means of which, when darted forward, the small insects which constitute its food are entangled.

In many birds the tongue, hard, pointed, or barbed, is thrust out as an offensive weapon, by means of a curious structure of appropriate muscles.

SOPHIA.

But it is difficult, in many of the examples which you have given, to state where the organ of taste can be, as the tongue is obviously incapable of acting in this capacity, from its hardness and insensibility.

DR. A.

It is probable, however, that the organ of taste may be situated behind, so as to receive its due gratification in the act of swallowing, which we know is the instant at which the enjoyment of the gourmand is complete.

END OF THE FIRST VOLUME.

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